BEHLMAN
Engineering Corporation

Electronic Energy Conversion Sources & Systems

MANUAL AND PARTS LIST

BEHLMAN MODEL UPS-50-11

UNINTERRUPTIBLE A.C. POWER SUPPLY

[redacted]

BATTERY MODULE MODEL BAT-6020-20

SERIAL #2417,#2418

BEHLMAN
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Electronic Energy Conversion Sources & Systems

WAR[redacted]

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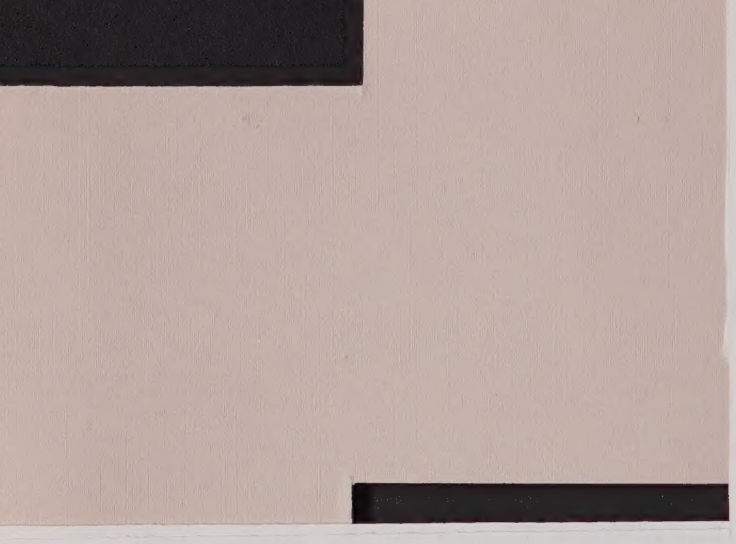

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Immediately upon receiving the instrument, unpack and inspect it for evidence of damage incurred in shipment. Unless the equipment has been extensively damaged and is obviously inoperable, check its operation. File a claim with the freight carrier if the equipment has been damaged in any way or if it fails to operate properly. Forward a copy of the damage claim report to Behlman Engineering Corp. Include the model number, serial number and date the shipment was received. Behlman Engineering Corp. will advise the disposition of the equipment and will arrange for the necessary repair or replacement.

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Do not return equipment to the factory without prior authorization from Behlman Engineering Corp.

If equipment is returned to the factory without prior authorization the customer is liable for all shipping, handling and repair costs.

When packaging for re-shippment, use adequate shock-absorbent material within shipping container to preclude damage to the equipment.

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SECTION 1 INTRODUCTION AND SPECIFICATIONS

1.1 GENERAL DESCRIPTION

The Behlman model UPS-50-11 Uninterruptible Power Supply (UPS) system provides a source of high quality AC power to critical electrical loads, regardless of the condition of the AC input power line. When normal AC line power is available the UPS isolates the load from line anomalies, such as voltage variations and transient noise. The model UPS-50-11 is capable of providing up to 500 volt-amperes of single phase AC power at a frequency of 60 Hz. The output voltage range is adjustable from 105-130 volts.

If a complete failure of the line occurs, or line anomalies exceed tolerable limits for normal UPS operations, an automatic switch to a battery supply allows the UPS to maintain an uninterrupted output to the load. A low-battery cutoff circuit will shut down the UPS when battery power has been exhausted. A built-in battery charger is provided to recharge the UPS batteries upon restoration of the AC input line.

A unique feature of the Behlman UPS is its use of a linear power amplifier to generate the AC output power. This amplifier inherently does not generate the high levels of EMI and RFI found in other UPS designs. By amplifiying a pure sinewave signal to the appropriate output level, distortion specifications of less than 1% are possible. In addition, the amplifier is tightly regulated, which results in excellent line and load stability specifications. Load power factors ranging from unity to zero, leading or lagging, can be handled by the UPS with no degradation in output specifications.

In the unlikely event of a UPS failure, a solid-state transfer switch is used to transfer the output load from UPS power to the AC input line power. The output load may also be manually switched between UPS power and line power by a front panel toggle switch.

Relay contact terminals are provided for external indication of input line failure, UPS output failure and low battery voltage.

The input power requirement is 115 Vac, 10 amperes, 60 Hz, single phase.

1.2 SPECIFICATIONS

MODEL UPS-50-11

1.2.1 SPECIFICATIONS-UPS

INPUT POWER:	115 Vac, 10 amperes, 60 Hz, single-phase.
STANDBY BATTERY REQUIREMENT:	60 Vdc, 17 amperes.
RATED OUTPUT POWER:	500 volt-amperes, single phase.
OUTPUT VOLTAGE RANGE:	105-130 Vac.
RATED OUTPUT CURRENT:	5 amperes.
FREQUENCY:	60 Hz $\pm$0.1%. (Phase-locked to power line).
DISTORTION:	1.0% maximum THD.
LOAD POWER FACTOR:	Down to zero, leading or lagging, at 25^{o}C ambient.
LOAD REGULATION:	$\pm$1.0% no load to full load. Adjustable through zero for a given load.
METERING:	Analog AC output voltmeter.
OVERLOAD AND SHORT CIRCUIT PROTECTION:	
UPS POWER MODE:	Instantaneous electronic protector plus line circuit breaker. Electronic protector returns output to normal as soon as overload or short circuit is removed.
LINE POWER MODE:	Fuse, ABC 8 amperes.
CIRCUIT BREAKER:	SYSTEM switch is a fast acting main and battery circuit breaker.
STATIC TRANSFER SWITCH:	
TRANSFER TIME:	Within 12mS.
TRANSFER VOLTAGE:	
REVERSE (UPS TO LINE):	105 Vac.
FORWARD (LINE TO UPS):	108 Vac.
BATTERY CHARGER:	
CURRENT:	Up to 3 ampere.
VOLTAGE:	60-72 Vdc.
BATTERY CHARGE TIME:	8-10 hours (No charge to full charge).
SIZE:	5.25"Hx19"Wx19"D.
WEIGHT:	65 lbs.

1.2.2 SPECIFICATIONS-BATTERY MODULE MODEL BAT-6020-20

VOLTAGE:	60 Vdc.
AMPERE-HOURS:	20
STANDBY TIME:	Approximately 30 minutes with UPS at 115 volts output and 500 VA load.
BATTERY TYPE:	6 volt, 10 ampere-hours. 20 batteries in series/parallel.
FUSE:	20 amperes.
SIZE:	5.25"Hx19"Wx19"D.
WEIGHT:	105 lbs.

SECITON 2 INSTALLATION

2.1 UNPACKING

After unpacking power supply, carefully conduct thorough inspection of controls, indicators and chassis. If power supply shows signs of damage do not attempt to operate. File a damage claim with the carrier responsible. Notify Behlman Engineering immediately.

2.2 INSTALLATION

1) This equipment is intended to be rack or cabinet mounted.

NOTE

The chassis must have bottom support when mounted in a rack or cabinet. (Unless slide mounted.) Do not attempt to mount by front panels only. For proper cooling air circulation the following clearances must be provided:

1.75" above UPS chassis (or above cabinet, with air-intake at top)
12" at front and rear of both chassis (or cabinet)

2) Be sure SYSTEM circuit breaker and OUTPUT switch are in OFF position.

DANGER

Due to the nature of UPS equipment the OUTPUT terminals and INPUT terminals are connected whenever the OUTPUT switch is in the ON position. The input power, if connected will then be present on the output terminals, possibly creating a hazardous condition. This is regardless of the position of the SYSTEM circuit breaker.

3) Connect BATTERY MODULE to UPS using the cable provided.

4) Plug suitable load/s into 3-wire OUTPUT receptacle/s located at the rear of the UPS chassis.

4) Plug the UPS AC line cord into a receptacle providing 115 Vac, 60 hz, single phase power.

SECTION 3 OPERATION

SAFETY NOTE

This equipment involves the use of voltages and currents that can be hazardous. Only qualified personnel should be allowed to operate or service it. The top cover/s must always be in placing during operation.

3.1 TO OPERATE THE EQUIPMENT

1) Place UPS POWER/LINE POWER switch in UPS POWER position. (Placing switch in LINE POWER position applies load directly to line power.)

2) Place SYSTEM circuit breaker in ON position.

3) Use OUTPUT VOLTAGE control to set output voltage to desired level, as observed on output voltmeter.

4) Place OUTPUT switch in ON position to energize load.

3.2 SHUTDOWN PROCEDURE

1) Place OUTPUT switch in OFF position.

2) Place SYSTEM circuit breaker in OFF position.

3.3 OVERLOAD AND SHORT CIRCUIT PROTECTION

3.3.1 OVERLOAD PROTECTION

1) With UPS POWER/LINE POWER switch in UPS POWER position:

   A) Output voltage will decrease in proportion to overload.

   B) Remove overload and output voltage will return to normal.

2) UPS POWER/LINE POWER switch in LINE POWER position:

   A) Bypass line fuse may blow, removing all power to load.

   B) Remove overload.

   C) Replace fuse per instructions below.

3.3.2 SHORT CIRCUIT PROTECTION

1) With UPS POWER/LINE POWER switch in UPS POWER position:

   A) Load will be transfered to input line power.

   B) Bypass line fuse will blow, removing all power to load.

C) Remove short circuit.

D) Replace fuse per instructions below.

2) With UPS POWER/LINE POWER switch in LINE POWER position:

A) Bypass line fuse will blow, removing all power to load.

B) Remove short circuit.

C) Replace fuse per instructions below.

3.4 BYPASS LINE FUSE REPLACEMENT

1) Place OUTPUT switch in OFF position.

2) Place SYSTEM circuit breaker in OFF position.

3) **DANGER: Remove input power from rear of unit.**

4) Replace fuse with proper size ABC type fuse. Fuse holder is located at rear of UPS chassis.

5) Re-connect input power per Section 2.2 INSTALLATION.

6) Follow instructions per Section 3.1 TO OPERATE THE EQUIPMENT.

3.5 UPS CONDITION INDICATORS

The following section describes various operating conditions as indicated by the front panel lights. It is assumed that the UPS system is working properly with the output voltage at a nominal value.

SYSTEM ON - GREEN LED

Indicates the SYSTEM circuit breaker is ON and AC line power and battery power has been applied to the UPS.

UPS OK - GREEN LED

Indicates the UPS is functioning properly and is capable of providing power to the load.

BATTERY CHARGED - AMBER LED

The UPS charger will supply charge current for the batteries as long as the SYSTEM circuit breaker is ON. The BATTERY CHARGED LED will light when the batteries are fully charged and placed on trickle charge. (LED may blink just before batteries reach full charge.)

LINE FAIL - RED LED

When lighted indicates a power line failure. The UPS will be deriving power from its batteries.

LOAD ON LINE - GREEN LED

Indicates the load is powered directly from the A.C. power line, bypassing the UPS. There are two conditions possible: (1) The load has been manually transferred to the AC line by means of the UPS POWER/LINE power switch or (2) With this switch in the UPS POWER position the UPS malfunctions. (NOTE: If the UPS malfunction causes the circuit breaker to trip, none of the indicators will be lighted; however, the load will be powered by the AC power line.)

LOAD ON UPS - GREEN LED

Indicates the load is powered by the UPS, either from line derived power or battery power. UPS POWER/LINE POWER switch must be in the UPS POWER position.

3.6 ALARMS

External alarm contacts are provided as follows:

Terminal	Indication
1 & 2	Line Fail
3 & 4	UPS Output Off
5 & 6	Low Battery

Contacts are configured as single-pole, single-throw; normally open; 1 ampere maximum.

SECTION 4 THEORY OF OPERATION

4.1 GENERAL ELECTRICAL DESCRIPTION

An electrical signal, at the desired output frequency and phase-locked to the input line, is generated by a sinewave oscillator. This signal is applied to the input of a driver amplifier. The push-pull output of the driver amplifier is applied to the input of a linear power amplifier. The power amplifier is transformer coupled to the output terminals through a solid-state transfer switch.

With the UPS POWER/LINE POWER switch in the UPS POWER position, power to the load is provided by the UPS. Only when this switch is in the LINE POWER position, or should the UPS fail, does power for the load come from the input line. The transfer between UPS power and line power is provided by solid state relays.

Should there be an input line failure, transfer to standby batteries occurs when the UPS D.C. voltage drops below a predetermined point. At this point an SCR fires and effects the transfer.

A D.C. supply section converts the A.C. input power to the various D.C. voltage and power levels required by the A.C. generating circuitry.

A built-in battery charger keeps the batteries charged as long as line power is available and the SYSTEM circuit breaker (or LINE and BATTERY circuit breakers) is in the ON position.

A separate battery charger may be provided, with its own LINE circuit breaker.

4.2 OSCILLATOR

4.2.1 GENERAL DESCRIPTION

The sinewave oscillator generates the variable-amplitude signal/s used to drive the power amplifier to the desired output frequency and voltage. In the absence of line power to the UPS the oscillator is freerunning. When the line is present the oscillator synchronizes with the line frequency. The capture range of the oscillator phase-locked-loop is $\pm$15%, with a 1 Hz per second slew rate to insure the load is not subjected to a rapidly changing output during synchronization loss or aquisition.

4.2.2 ELECTRICAL DESCRIPTION

The oscillator is a Wien-bridge design using a quad operational amplifier. Two of the four sections are used as unity gain 120^{o} phase shifters. One section is employed as a variable-gain amplifier having a nominal gain of unity. The fourth section compares a positive voltage, obtained by rectifying the A.C. output of the variable-gain amplifier, to a positive voltage determined by the setting of the voltage-adjust potentiometer. Differences between these two voltages are amplified and applied to the gate of a field-effect transistor used in the voltage-controlled variable-resistance mode. The FET controls the negative feedback of the variable-gain amplifier in such a way as to oppose changes in the amplitude of its output.

The variable-gain amplifier generate the output signal on single-phase oscillators, and the AØ signal on three-phase oscillators. This signal also goes to the input of the first 120^{O} phase shifter. The output of this phase shifter provides the BØ signal on three-phase oscillators and also goes to the input of the second 120^{O} phase shifter. The output of this phase shifter provides the CØ signal on three-phase oscillators.

A resistance bridge is used between the BØ and CØ signals to provide positive feedback for the input of the variable-gain amplifier, thus sustaining oscillations.

4.3 DRIVER

4.3.1 GENERAL DESCRIPTION

The driver provides push-pull signals, at appropriate voltage and current levels, to the input of the power output stage. The driver also provides output overload and short circuit sensing and protection functions. One driver is used on single-phase models and three drivers are used on three-phase models.

4.3.2 ELECTRICAL DESCRIPTION

An electrical signal, from the oscillator, is applied to the input of the driver through resistor R1. Negative-feedback signals from the output of operational amplifier A3D are applied through R24. Summation of the oscillator and negative feedback signals is obtained at the junction of R1 and R24. Summation voltages are applied to the non-inverting input of op-amp A1, and to the inverting input of op-amp A2 through R3. This results in the generation of push-pull signals at the outputs of op-amps A1 and A2.

The outputs of op-amps A1 and A2 are applied to the gates of power FETs Q1 and Q2, through R22, D9 and R17, D10. Q1 and Q2 are used as source-followers, and provide outputs at suitable voltage and current levels to drive the push-pull power output stage.

Negative-feedback voltages are generated by op-amp A3D. This amplifier is used in a differential mode, using signals derived from the primary of the power ouput transformer. Resistors R32, R33, R34 and R35 are used to reduce the D.C. and A.C. voltages, at the primary of the power output transformer, to appropriate levels for use by the op-amp.

Positive-feedback signals are used to provide additional reduction in the output impedance of the power output stage. Positive-feedback voltage is derived at the output of op-amp A1 and applied to the summation junction of R1 and R24, through R37, R11, C6 and R12 and R10. C4 is used to provide high-frequency roll-off of the positive-feedback signals. R11 is used to adjust the positive feedback to the desired level. This positive feedback arrangement provides very high gain in the operational band of frequencies. This high gain, combined with the very high degree of negative feedback, derived from the power output stage, provides a very low output impedance.

Driver output bias voltages are obtained by the use of R6 and R8.

4.3.2.1 POSITIVE FEEDBACK REDUCTION WITH LOW POWER FACTOR LOADS:

By reducing the positive feedback as the load power factor is decreased, no-load to full-load regulation is greatly improved. It also increases the margin of stability when using capacitive loads.

Op-amps A2 and A3D are used to monitor the phase difference between the voltage across the load and the current through the load. The positive feedback is then reduced in proportion to the phase difference. The voltage signal is obtained from the output of negative-feedback amplifier A3D. The current signal is obtained from the output of driver amplifier A2. These voltage and current signals are converted to square waves by overdriving op-amps A3A and A3B with them. As the power factor of the load decreases A.C. current flows through R21 and photoresistor U1, whose resistance varies inversely with current. The photo-resitance is thereby lowered and shunts positive feedback, at the junction of R10 and R12, to ground.

4.3.2.2 OVERLOAD FUNCTIONS:

Excessive current through the load is reflected as high drive voltage at the outputs of source-followers Q1 and Q2. These high drive signals turn-on Q3 which then loads the inputs to the gates of Q1 and Q2. This reduces the drive voltages, and thereby the output current, to pre-set and safe levels. Clipping of the output voltage results.

A foldback function is provided that reduces the maximum output current as output voltage is reduced or as the load on the output is increased. Op-amp A3C is used as a unity-gain amplifier which buffers the output of negative-feedback amplifier A3D. The output of A3C is applied to D7 which results in a negative D.C. voltage appearing at the junction of D7, R13 and C5. This negative voltage is applied in such a way as to oppose and reduce the positive base signals appearing at Q3. As long as the output voltage is high enough to allow D8 to roughly regulate the negative voltage appearing across it, maximum current can be obtained through the load. If the negative voltage across D8 is reduced, either by very heavy loads across the power supply output or very low output-voltage settings, there is less or no voltage to oppose the positive base signals. Therefore, Q3 will conduct at lower driver output voltages, which results in conducting at lower output currents.

C5 and C7 provide time delays which allow short-term, high-inrush currents and high narrow-peak recurrent-currents through the load.

4.4 POWER OUTPUT STAGE

4.4.1 GENERAL DESCRIPTION

The power output stage takes low level signals from the driver and amplifies them to the power level required at the output of the UPS. One stage is used on single-phase models and three are used on three-phase models.

4.4.2 ELECTRICAL DESCRIPTION

The power output stage is a push-pull stage employing transformer coupling between the collectors of NPN power transistors and the output to the solid-state transfer switch.

Two of the output stage transistors are connected in a darlington configuration. A push-pull signal from the driver is applied to the bases of the darlington transistors, which in turn drive the rest of the output transistors. Up to 30 output transistors may be driven by each darlington pair.

Resistors in the emitter circuits of each pair of transistors protect against thermal runaway and force each transistor to take its "fair share" of load current. The number of transistors employed depends upon the power output required of the stage.

An R-C roll-off network is used to provide the necessary margin of stability.

4.5 SOLID-STATE TRANSFER SWITCH

4.5.1 GENERAL DESCRIPTION

The transfer-switch assembly provides the following functions:

1. Load Transfer: Transfers the load between UPS output power and AC line power by controlling solid-state relays. This is done automatically should the UPS fail, or may be controlled manually using the front panel manual transfer switch.

2. Low Battery Alarm: A provision for an external alarm to signal low battery voltage, before the cutoff circuit (located on UPS Adaptor P/C Board) shuts down the UPS.

3. Line Fail Alarm: A provision for an external alarm to signal a power line failure.

4. UPS Off Alarm: A provision for an external alarm to signal a UPS failure.

5. Load-on-Line Alarm: A provision for an external alarm to signal that the load is powered directly by the input line. (Optional)

6. Load-on-UPS Alarm: A provision for an external alarm to signal that the load is powered by the UPS. (Optional)

4.5.2 ELECTRICAL DESCRIPTION

4.5.2.1 LOAD TRANSFER SWITCH

The transfer switch continuously monitors the A.C. output of the UPS. The A.C. is converted to a fast responding D.C., which drives op-amp A2B used in the level-detector mode. The output of the op-amp is applied to a dual-firing detecting circuit, to assure that only one solid-state relay is on at a time. Should the UPS fail, the level detector is set to effect the load transfer at a predetermined UPS output level.

4.5.2.1 LOW BATTERY ALARM

Zener diodes are used to determine the cutoff point, during battery discharge, and the turn-on point, during battery charge, of FET Q2. This triggers FET Q3, which controls DC power to the low-battery alarm relay.

4.6 UPS ADAPTOR

4.6.1 GENERAL DESCRIPTION

This adaptor provides the following functions:

1. Battery charger control. (May be located in battery charger chassis.)

2. Battery Transfer Switch: Transfers from the line derived main D.C. power to battery power whenever the input line fails.

3. Low-Battery Cutoff Circuit: A provision to shut down the UPS at a pre-set battery voltage level.

4. Standby $\pm$16 VDC Supplies: Provides $\pm$16 VDC for use in various circuits when the UPS is operating on battery power.

4.6.2 ELECTRICAL DESCRIPTION

4.6.2.1 BATTERY CHARGER

The battery charger will charge a low battery at a constant-current rate until the battery voltage reaches approximately 72 volts. At this point the charger voltage drops back to 67 volts and the battery is placed in a "float" mode. The charger utilizes series-pass transistors and associated zener diodes to generate the required current and voltages. An SCR is used to bypass a 5.1 volt zener diode when the battery voltage reaches 72 volts. This automatically reduces the charger voltage by 5 volts and also lights the BATT. CHGD. indicator.

4.6.2.2 BATTERY TRANSFER SWITCH

One or more SCRs are used to block the battery voltage from the power output stage collector supply. Should the input line fail the transfer switch fires the SCR/s at a predetermined value of collector supply voltage, effecting the transfer from line power to battery power within a few microseconds.

4.6.2.3 LOW-BATTERY CUTOFF CIRCUIT

Zener diodes determine the cutoff point, during battery discharge, and the turn-on point, during battery charge, of an FET. This triggers a switching FET, which controls battery power to the standby $\pm$16 Vdc supplies.

4.6.2.4 STANDBY +16 Vdc SUPPLY

A zener diode regulated supply operating off battery 60 Vdc. This supply operates in addition to the AC derived +16 Vdc supply.

4.6.2.5 STANDBY -16 Vdc SUPPLY

The standby -16 Vdc supply operates off battery 60 Vdc. The output of a relaxation oscillator is converted to rectangular pulses in a transistor amplifier stage. The output of this stage is rectified, filtered and zener regulated. This supply operates in addition to the AC derived -16 Vdc supply.

4.7 D.C. POWER SUPPLY

4.7.1 GENERAL DESCRIPTION

DC power, of both polarities and at several voltage and current levels, is required for the various stages in the AC Power Supply.

$\pm$16 Vdc regulated is required by the oscillator and driver/s.

+60 Vdc, at high current levels, is required by the power output stage collectors. On 350-1500 VA models this is a regulated voltage. On models up to 350 VA, or on models with three-phase input, this is an unregulated voltage.

4.7.2 ELECTRICAL DESCRIPTION

The $\pm$16 regulated voltages are I.C. regulated, full-wave bridge-rectifier power supplies. AC power for the supplies is from a low power input transformer.

The +60 unregulated voltage is a filtered, full-wave bridge-rectifier power supply. AC power for this supply is from a high power input transformer. On models with three-phase input a set of diode-doublers is used in the same manner.

On 350 VA and larger models, with single-phase input, the +60 supply uses a switching regulator to improve the efficiency of the power output stage. An op-amp is used to turn-on switching transistors when the voltage is too low, and vice versa. Turning-on the switching transistors causes the output filter-capacitor voltage to rise as it receives current from the raw +60 supply. When the voltage rises to the correct level the comparator-switch turns off the switching transistors. Capacitor charging-currents are limited by use of a reactor. Flyback voltage across this reactor is also channeled into the output capacitor through a diode.

A very fast acting circuit breaker is used to monitor the power output stage collector current. If this current exceeds a predetermined value, the circuit breaker trips and removes all input power to the unit. This circuit breaker provides additional protection to that provided by the instantaneous electronic protection. On most 100-1000 VA models this circuit breaker also monitors and controls battery current. On most 1500 VA and larger models a seperate battery circuit breaker is used.

SECTION 5 MAINTENANCE AND CALIBRATION

SAFETY NOTE

This equipment involves the use of voltages and currents that can be hazardous. Only qualified personnel should be allowed to operate or service it.

Before performing any of the following maintenance procedures, where access to the inside of the equipment is required, be sure to place the circuit breaker/s in the OFF position, remove the input power to the equipment, and to discharge the D.C. power supply filter capacitor/s. Use a 25 ohm, 25 watt resistor to first discharge capacitor C2 (when used) and then capacitor C1. (See chassis layout drawings for location of the capacitors.)

5.1 MAINTENANCE

5.1.1 AIR FILTERS

Air filters, when used, should be cleaned every six months, or more often if required. Metal mesh filters should be removed, cleaned in soapy water, rinsed, dried and sprayed with an appropriate filter spray. Plastic foam filters merely require cleaning with a vacuum cleaner from the outside.

5.2 ADJUSTMENTS

Before performing the following adjustments, allow the equipment to warm up for approximately one hour, with the top cover/s on and no output load. The use of a printed circuit card extender is recommentded to make the adjustments easier. Be sure to follow the above note regarding discharge of the D.C. power supply filter capacitor/s before removing any of the printed circuit boards.

Note: Incandescent light bulbs should not be used as a load when making these adjustments as their high inrush current nature will erroneously effect the results. The use of a resitive load, such as a heating element, is recommended.

5.2.1 DRIVER POSITIVE FEEDBACK ADJUSTMENT

With the power supply output voltage adjusted to the desired level and the output-switch in the ON position, connect a load of appropriate value to the output terminals. Note the variation in output voltage as the load is connected. Adjust the positive-feedback potentiometer (R11), with the load connected, so as to obtain the same output voltage as in the unloaded state, within the specifications of the unit.

5.2.2 DRIVER OVERLOAD AJUSTMENT

This adjustment should be made with the use of an oscilloscope monitoring the output voltage waveshape. Select a resistive load that will draw 100-115% of the rated output current at 85-94% of the maximum output voltage (110-122 volts on 105-130 volt model).

Example:
Output power: 1000 VA Output voltage: 105-130 volts. Output current: 10 amperes.
Selected test voltage: 115 volts (85-94% of 130 volts).
Selected test current: 11.5 amperes (100-115% of 10 amperes).
Calculated test load: 115V/11.5A=100 ohms, 1000 watts.

With the load applied to the output terminals, and the output switch in the ON position, increase the output voltage to 115 volts (the voltage at which the calculations were made). At this point the peaks of the output sinewave should just begin to clip. If this clipping onset does not occur, adjustment of the overload potentiometer (R14) should be made. The clipping level is designed to vary somewhat with temperature, so as to limit the output to lower levels at higher temperatures.

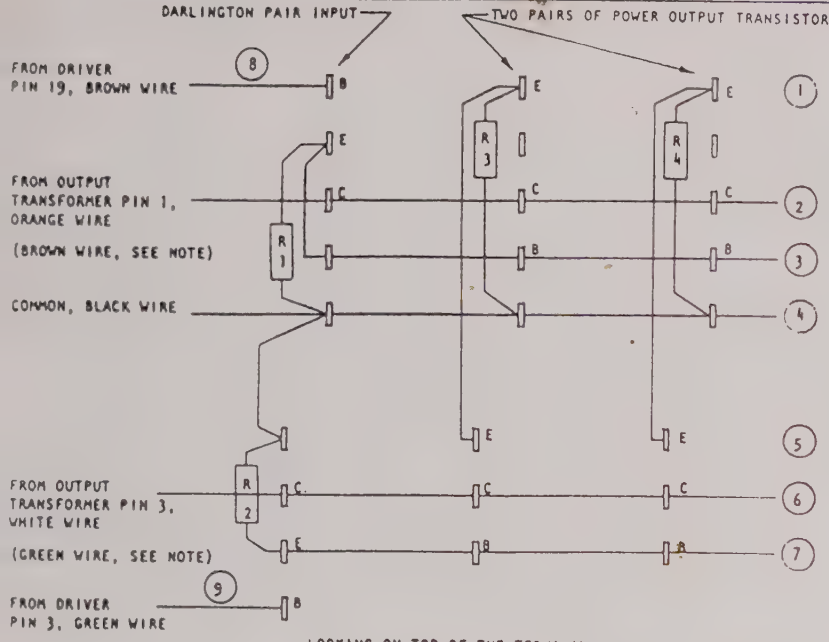
If an oscilloscope is not available the above adjustment can be made by connecting the appropriate load, increasing the output voltage, and observing the point at which this voltage drops off. This provides an indication of the onset of clipping.

NOTE

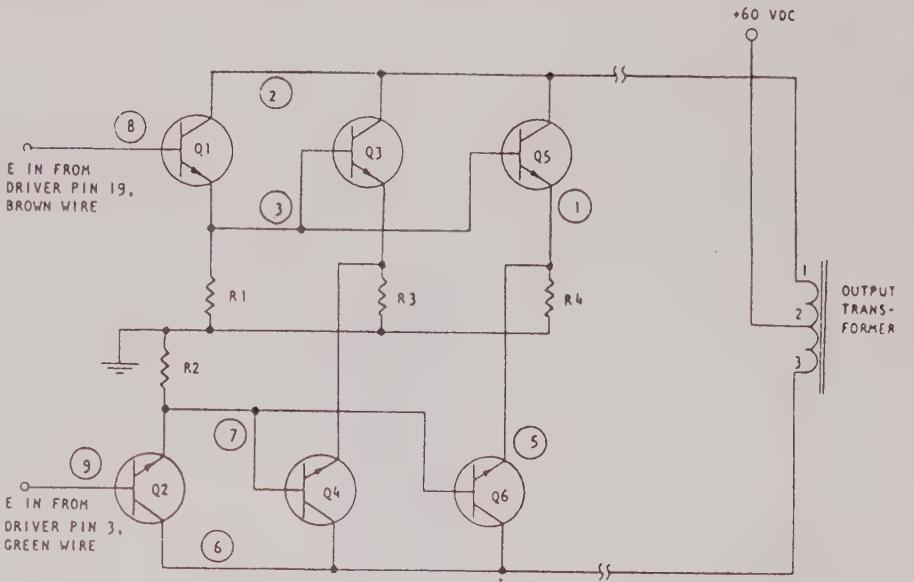
On multi-phase models (wye or delta outputs) make the above adjustments on one phase and then proceed to the next. On delta output models a neutral output terminal is provided for connecting the test loads from line to neutral rather than line to line. If this is not done, making an adjustment on one phase will effect the other phase/s and vice versa. Be sure to use line-neutral, not line-line, specifications.

5.3 TROUBLESHOOTING

If the circuit breaker trips, and cannot be reset, the most likely problem is a defective power output stage transistor. Refer to Troubleshooting Procedure drawing.



LOOKING ON TOP OF THE TERMINAL STRIPS OF A TYPICAL POWER OUTPUT STAGE.



CORRESPONDING SCHEMATIC OF COMPONENT LAYOUT SHOWN AT LEFT.

TROUBLESHOOTING PROCEDURE.

1. Defective darlington input transistors. Check B-E, B-C, E-C of Q1 and Q2 with ohmmeter.
2. Connect an ohmmeter* between (1) and (2), and then between (5) and (6). One way reads high, the other low (e.g., from collector through base, R1 and R4.) However, if one output stage consists of two stacks and each stack is located in a different chassis and the cable between chassis is disconnected, then the stack not having the darlington pair will read high both ways between (1) and (2), and (5) and (6). Without interconnecting cable ground connections may be open.
3. Collector to emitter short. Determine if the short is between (2) and (1) or (6) and (5). Connect one ohmmeter lead to the collector buswire and the other lead to each emitter, in turn. Read approx. 1 to 2 ohms. A lower reading indicates the defective transistor. Check both directions, see step 2.
4. Collector to base short. Determine if the short is between (2) and (3) or (6) and (7). (The ohmmeter reads low both ways.) Start cutting the base buswire from each base connection (3) or (7) until the defective transistor is isolated.
5. Emitter to base short. Determine if the short is between (3) and (1) or (7) and (5). It may help to lift the base buswire from R1 and/or R2. Connect one ohmmeter lead to the base buswire (3) or (7) and the other to each emitter, in turn. Since the meter reads through the emitter resistor of a good stage, the shorted transistor will have a near zero reading.

NOTE:

R1 & R2 can be 2 ohm, 1 ohm, or 1 ohm paralleled by 5.1 ohm, depending on number of output transistors. R3 and R4 are 0.5 ohm. The bases (7) & (3) may have green and brown wires, respectively, connected to them. These are interconnecting wires if an output stage consists of two or more individual stacks, but only one darlington pair.

(1) Refers to test points.

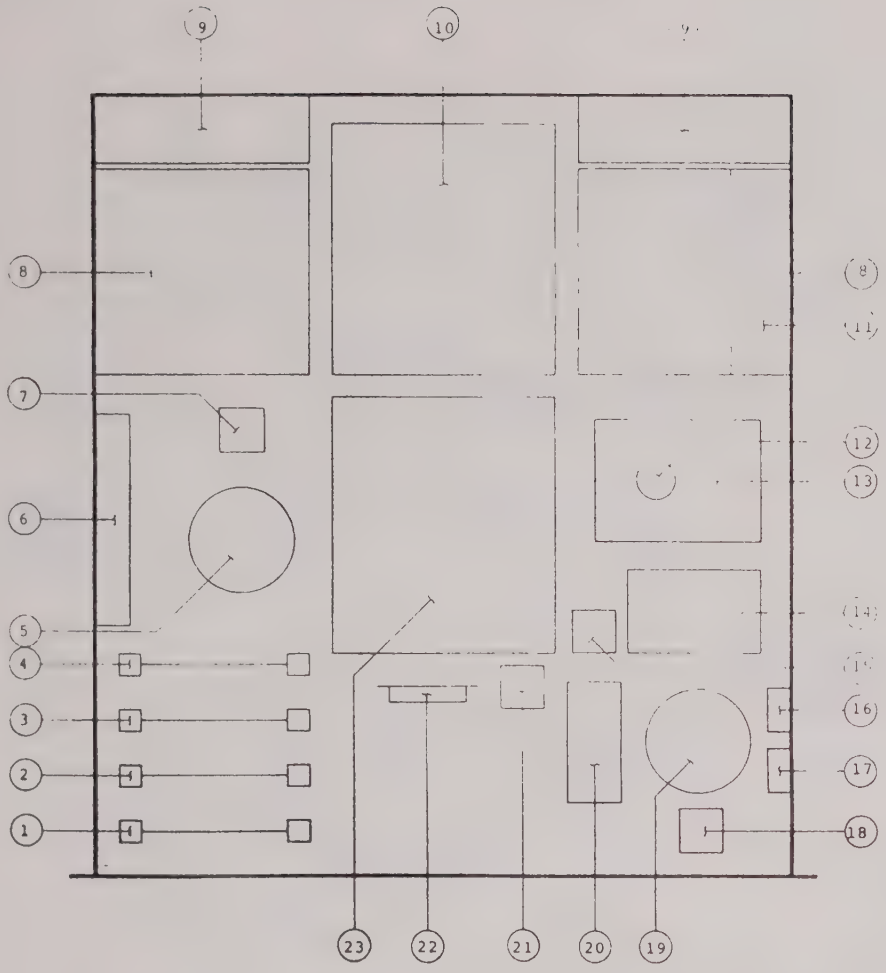
Steps 2 to 5 of the troubleshooting procedure refer to power output transistors Q3-4-5-6-

*Use an analog meter such as the Simpson 260 or 269, or the Triplett 630A.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 8/3/81	REVISED
TITLE TROUBLESHOOTING PROCEDURE FOR POWER OUTPUT STAGE	
MODEL	DRAWING NO. B-1395

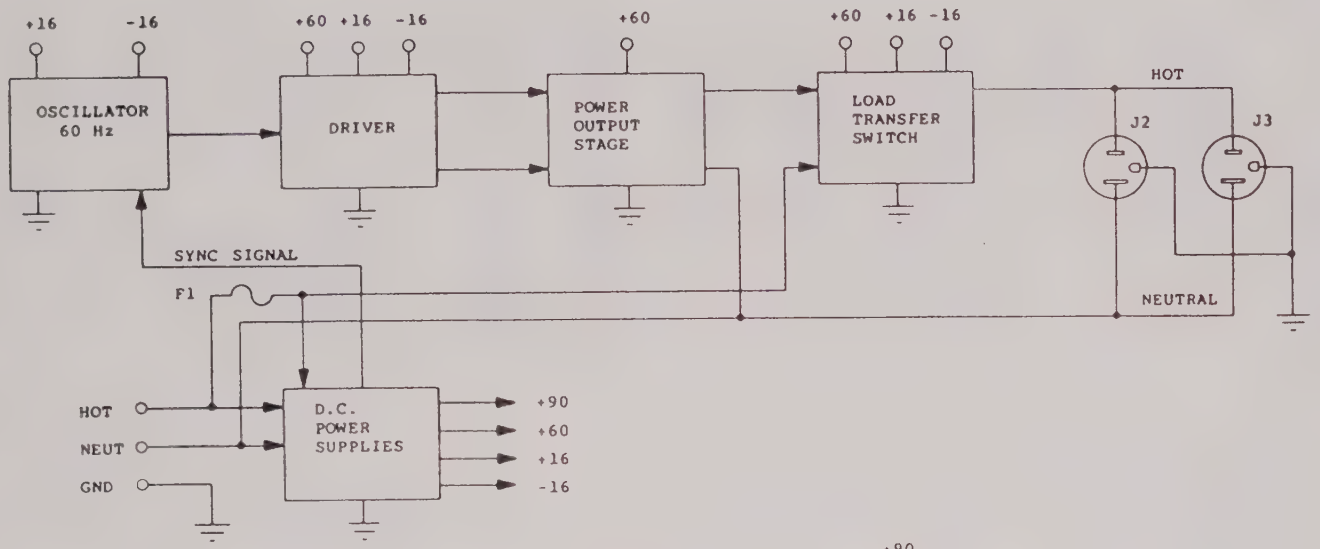
SECTION 6 SCHEMATIC AND PARTS LIST

UNINTERRUPTIBLE POWER SUPPLY



ITEM #	DESCRIPTION	SYMBOL	DWG. NO.
1	OSCILLATOR	ASSY 16-139	B-1872
2	DRIVER	DR-9	B-1274
3	±16VDC SUPPLY		
	+60VDC CONTROL CIRCUITRY	ASSY 16-129	B-1307
4	UPS ADAPTOR	ASSY 16-164	B-1357
	CAPACITOR	C1	B-2307
5	LOAD TRANSFER SWITCH	ASSY 16-085	C-1003
6	BRIDGE RECTIFIER	BR1	B-2307
8	TRANSISTORS(POWER OUTPUT)	Q1-16	B-1999
9	FANS (COOLING)	B1,2	B-1999
10	TRANSFORMER (POWER INPUT)	T1 -	B-2307
11	TRANSISTORS (BATTERY CHARGER)	Q1-3	B-1357
12	SILICON CONTROLLED RECTIFIER	SCR1	B-1357
13	TRANSISTORS (+60 REGULATORS)	Q2-6	B-2307
14	REACTOR	L1	B-2307
15	BRIDGE RECTIFIER	BR2	B-2307
16	SOLID STATE RELAY	K2	C-1001
17	SOLID STATE RELAY	K1	C-1001
18	BRIDGE RECTIFIER	D1	B-2307
19	CAPACITOR	C2	B-2307
20	TRANSFORMER (POWER INPUT)	T2	B-2307
21	BRIDGE RECTIFIER	BR2	B-1999
22	COLLECTOR ROLL-OFF	ASSY 16-009	B-1999
23	TRANSFORMER (POWER OUTPUT)	T1	B-1999

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY
DATE 8/21/84	REVISED
TITLE CHASSIS LAYOUT	
MODEL UPS-50-	DRAWING NO B-2341

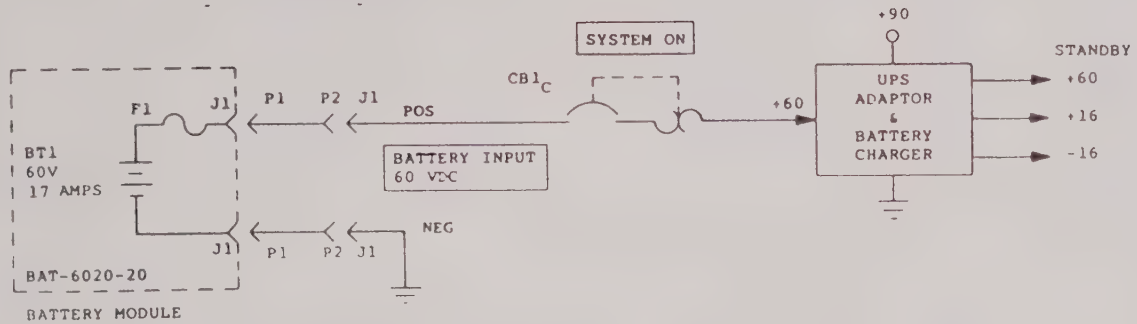


A.C. POWER OUTPUT

500 VA, 1Ø
105-130 VAC
60 Hz

LINE IN:

115 VAC, 1Ø
60 Hz



BATTERY MODULE

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 9/15/83	REVISED
TITLE BLOCK DIAGRAM	
MODEL UPS-50-11	DRAWING NO B-2093

BISHOP GRAPHICS, ACCUPRESS
REORDER NO 411215

PARTS LIST

Description BLOCK DIAGRAM

Model UPS-50

Assembly/part no.

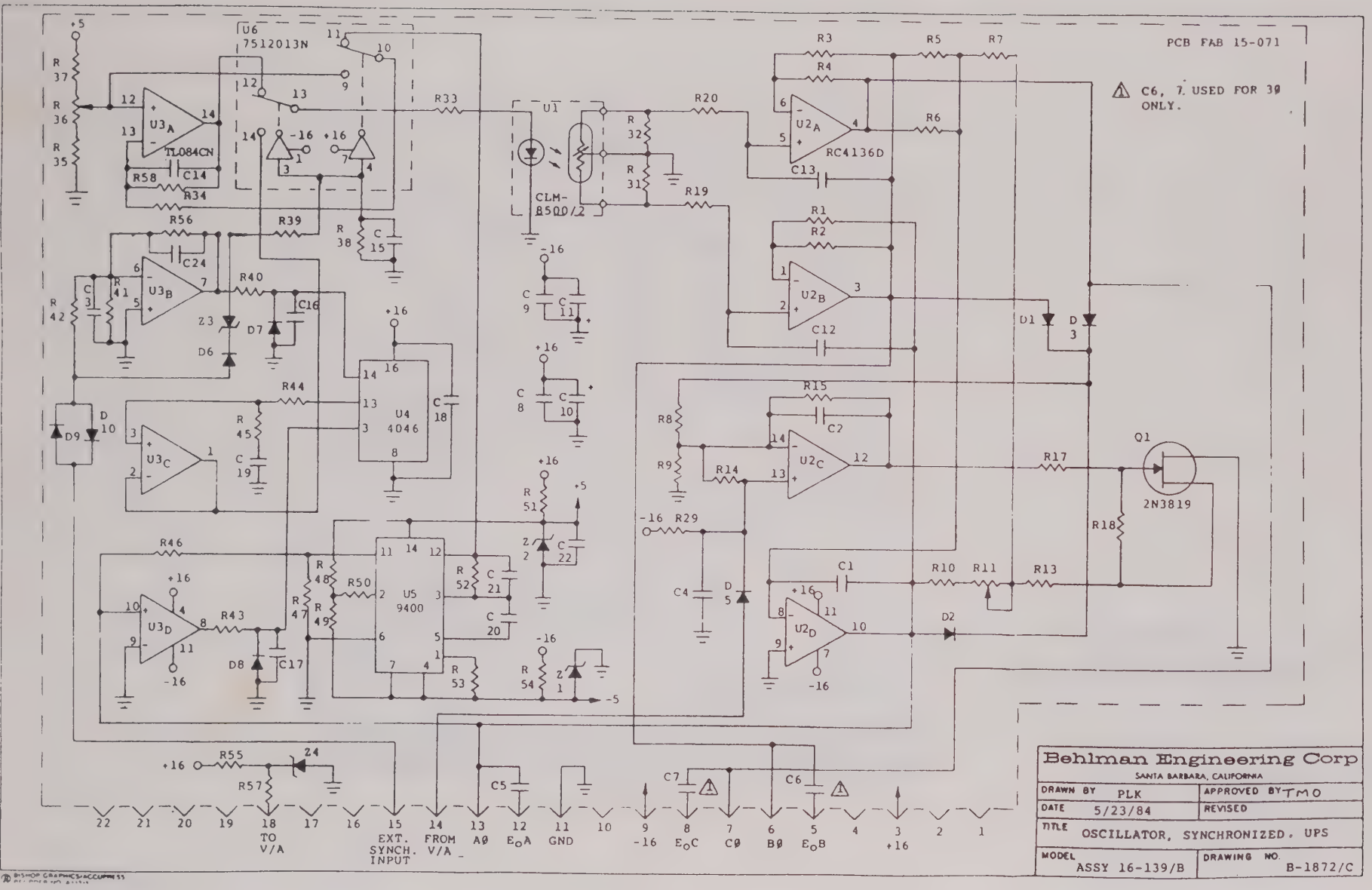
Drawing/ref no. B-2093

Page 1 of 1

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
CB1	Circuit breaker 3 Pole	UPG-666-4-60-502	Airpax
F1	Fuse 8A, 250V	ABC 8	Bussmann
J1	Connector, Receptacle 4 contact, Pin	MS3102A-14S-2P	Amphenol
J2,3	Connector, 3 terminal Outlet, 15A, 125V	5279	Bryant
P1	Connector, Plug 4 contact, Pin	MS3106A-14S-2P	Amphenol
P2	Connector, Plug 4 conmtact, Socket	MS3106A-14S-2S	Amphenol

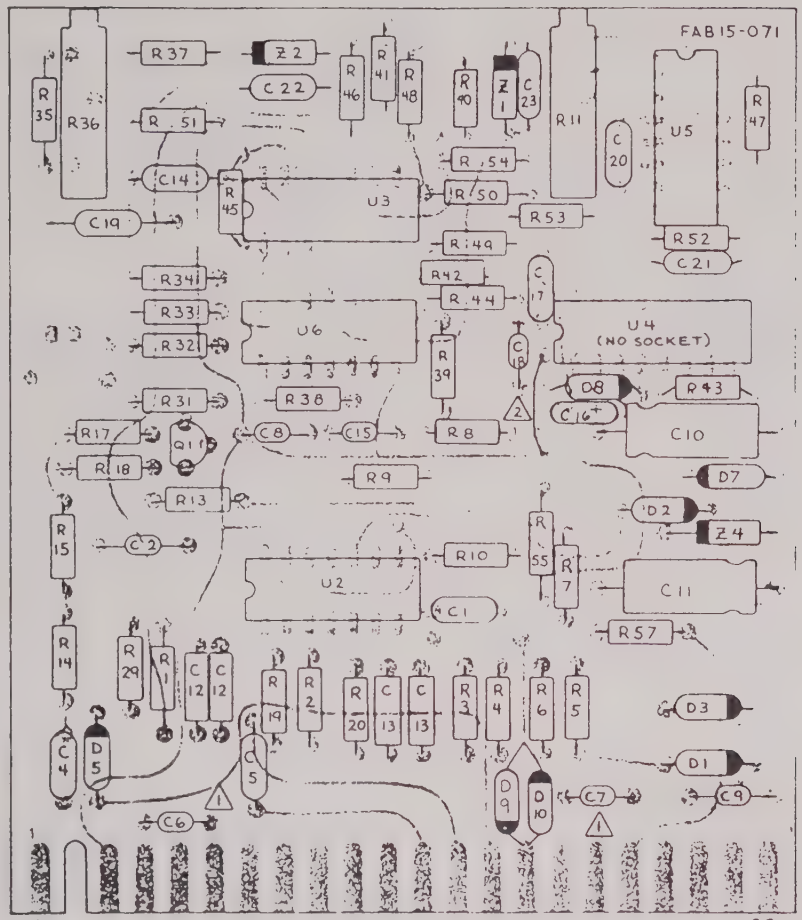
BATTERY MODULE: BAT-6020-20

BT1	Battery 6 Volt, 10 Ampere-Hours Twenty in series/parallel	NP10-6	Yuasa
F1	Fuse 20A, 250V	ABC 20	Bussmann
J1	Connector, Receptacle 4 contact, Socket	MS3102A-14S-2S	Amphenol



Behlman Engineering Corp	
SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY TMO
DATE 5/23/84	REVISED
TITLE OSCILLATOR, SYNCHRONIZED, UPS	
MODEL ASSY 16-139/B	DRAWING NO. B-1872/C

BISHOP GRAPHICS/ACCUPRESS



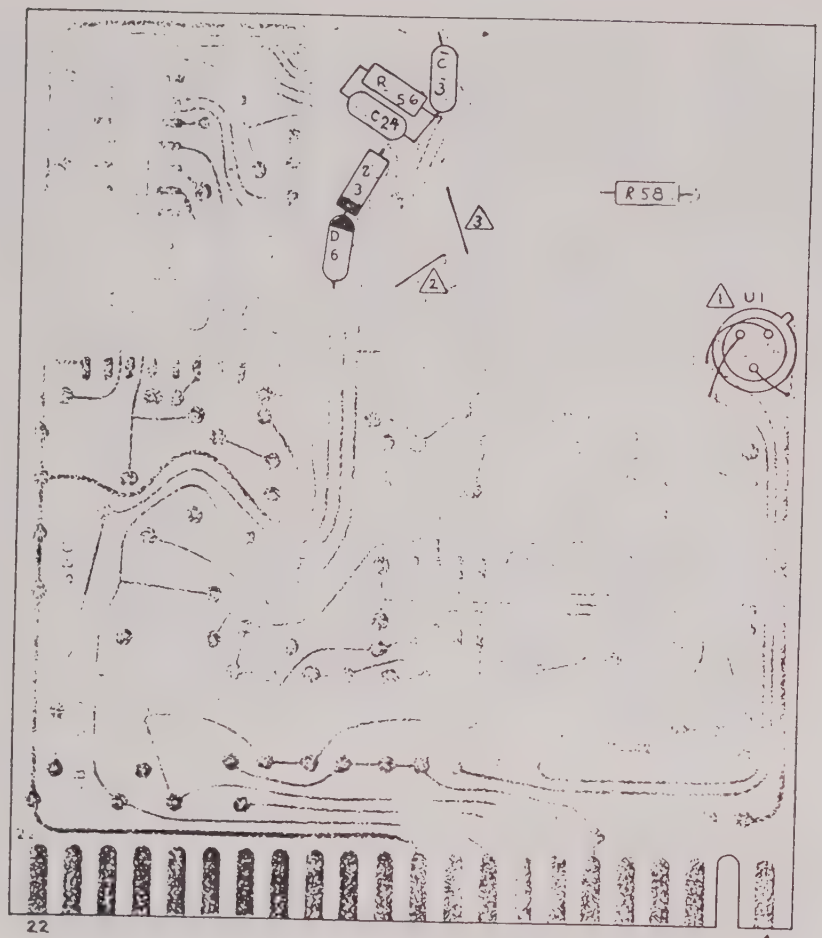
(COMPONENT SIDE)

1 C6,7 USED ONLY FOR 3Ø

2 JUMPER, NO. 26AWG BUSS WIRE, TEFLON-SLEEVED.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY RK	APPROVED BY
DATE 5/23/84	SCHEMATIC: B-1872/C
TITLE COMPONENT LAYOUT, UPS OSCILLATOR	
MODEL ASSY 16-139/B	DRAWING B-1873/B SHEET 1 of 2

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. 811215



(CIRCUIT SIDE)

3 JUMPERS, NO. 26 AWG BUSS WIRE, TEFLON-SLEEVED.

2 TRACE CUTS AT U3, PINS 5 & 6

1 LEADS FROM U1 TEFLON-SLEEVED.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY RK	APPROVED BY
DATE	SCHEMATIC: B-1872/C
TITLE COMPONENT LAYOUT, UPS OSCILLATOR	
MODEL ASSY 16-139/B	DRAWING B-1873/B SHEET 2 of 2

BISHOP GRAPHICS/ACCUPRESS
RECORDER NO. A11715

PARTS LIST

Description OSCILLATOR, UPS 50, 60 Hz

Model

Assembly/part no. 16-139/B

Drawing/ref no. B-1872/C, B-1873/B

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1	Capacitor, Disk 39pF, 1000V	DD-390	Centralab
*C2	Capacitor, Monolythic .1uF,25V	SR205E104MAA	AVX
C3	Capacitor, Monolythic .05uF, 100V	TG-S50	Sprague
**C4-7,14 19,22,23	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M050B	Sprague
C8,9,15,18	Capacitor, Monolythic .1uF, 25V	SR205E104MAA	AVX
C10,11	Capacitor, Electrolytic 15uF, 25V	TVA-1204.2	Sprague
*C12,13	Capacitor, Polycarbonate .022uF, 160V	B5A223	Elpac
C16,17	Capacitor, Dipped mica 100pF, 500V	CM05F0101J03	CDE
C20,21	Capacitor, Dipped mica 1000pF, 500V	CM06FD102J03	CDE
C24	Capacitor, Dipped mica 200pF, 500V	CM05FD201J03	CDE
D1-3, 5-8	Diode 1A, 400V	1N4004	Motorola
D4,	Not used		
D9,10	Diode, Signal 20mA, 100V	1N914A	Motorola
Q1	Field effect transistor 10mA, 25V	2N3819	Siliconix
R1-6,31 32,42	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R7,55	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	

PARTS LIST

Description OSCILLATOR, UPS 50, 60 Hz
Assembly/part no. 16-139/B
Drawing/ref no. B-1872/C, B-1873/B

Model

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R8	Resistor, Metal film 4.7K, 1/4W, 1%	RN55D 4701F	
R9,52,58	Resistor, Carbon comp. 10Meg, 1/4W, 5%	RC07GF106J	Allen Bradley
R10	Resistor, Metal film 13.7K, 1/4W, 1%	RN55D 1372F	
R11,36	Potentiometer, Cerment 5K, 20 Turn	89PR5K	Beckman
R12,16, 21-28,30,	Not used		
R13	Resistor, Metal film 2.61K, 1/4W, 1%	RN55D 2611F	
R14,18,29, 38,44,45,53	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R15	Resistor, Metal film 1 Meg, 1/4W, 1%	RN55D 1004F	
R17	Resistor, Metal film 205K, 1/4W, 1%	RN55D 2053F	
R19,20	Resistor, Metal film Select at test. Appox. values: 50 Hz model: 73.2K, 1/4W, 1% 60 Hz model: 60.4K, 1/4W, 1%	RN55D 7322F RN55D 6042F	
R33	Resistor, Metal film 6.8K, 1/4W, 1%	RN55D 6801F	
R34	Resistor, Metal film 110K, 1/4W, 1%	RN55D 1103F	
R35,37,47	Resistor, Metal film 1.5K, 1/4W, 1%	RN55D 1501F	
R39	Resistor, Metal film 52.32K, 1/4W, 1%	RN55D 5232F	

PARTS LIST

Description OSCILLATOR, UPS 50, 60 Hz
Assembly/part no. 16-139/B
Drawing/ref no. B-1872/C, B-1873/B

Model

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R40,43	Resistor, Metal film 2.32K, 1/4W, 1%	RN55D 2321F	
R41	Resistor, Metal film 6.3K, 1/4W, 1%	RN55D 6301F	
R46	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
R48	Resistor, Metal film 54.9K, 1/4W, 1%	RN55D 5492F	
R49	Resistor, Metal film 46.4K, 1/4W, 1%	RN55D 4642F	
R50	Resistor, Metal film 49.9K, 1/4W, 1%	RN55D 4992F	
R51,54	Resistor, Metal film 1.13K, 1/4W, 1%	RN55D 1131F	
R56	Resistor, Metal film 499K, 1/4W, 1%	RN55D 4993F	
*R57	Resistor, Metal film 3K, 1/4W, 1%	RN55D 3001F	
U1	Photo-Coupled Resistor	CLM-8500/2	Clairex
U2	Quad operational amplifier	RC4136D	Raytheon
U3	Quad operational amplifier	TL084CN	TI
U4	Phase locked loop	CD4046BE	RCA
U5	Frequency to Voltage Converter	9400CJ	Teledyne
U6	Analog switch	MP7512/D1JN	Micropower
Z1,2	Zener diode 5.1V, 1W	1N4733A	Motorola

PARTS LIST

Description OSCILLATOR, UPS 50, 60 Hz
Assembly/part no. 16-139/B
Drawing/ref no. B-1872/C, B-1873/B

Model

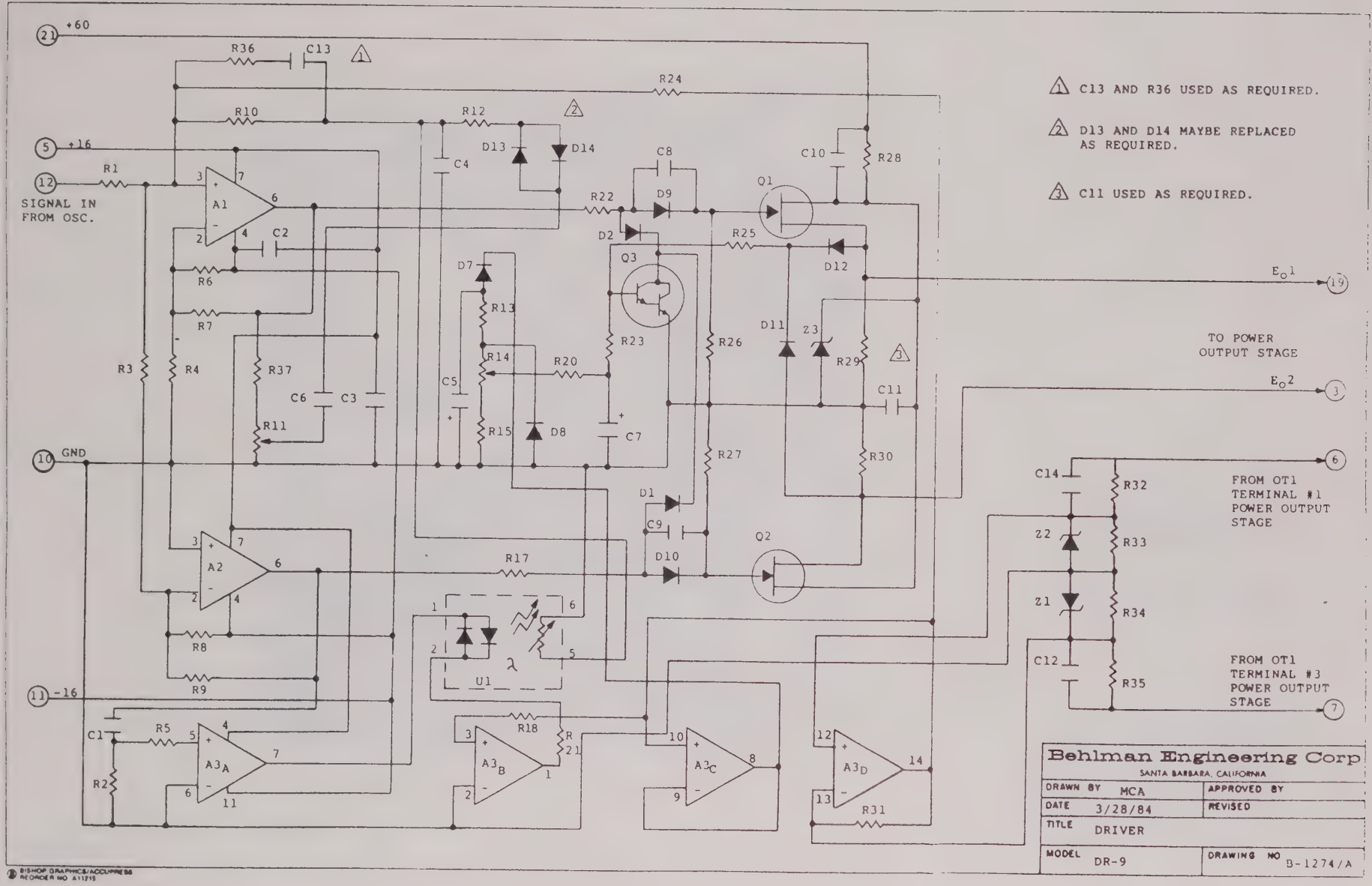
Page 4 of 4

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
Z3	Zener diode 10V, 1W	1N4740A	Motorola
Z4	Zener diode 14V, 1/2W	1N5244	Motorola
4 pcs	IC socket 14 contact	14S-TSD	CA
1 pc	Printed circuit board	15-071	Behlman Eng.

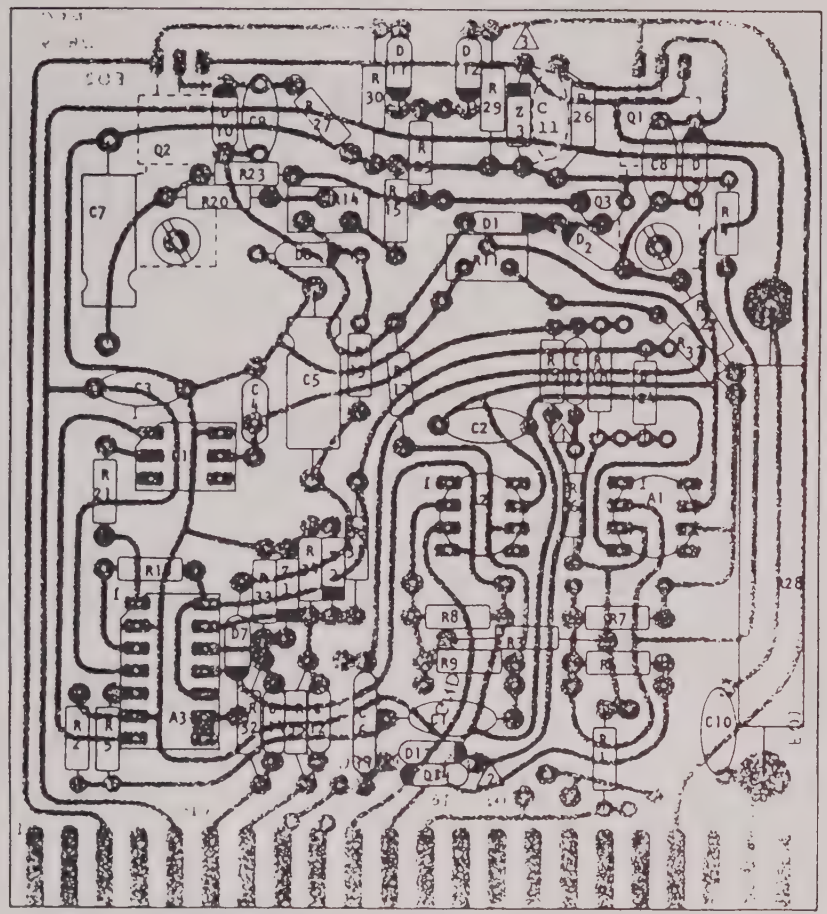
CHASSIS COMPONENTS/ASSEMBLIES

R59	Potentiometer 10K, 2W, 10 Turn	534-10K	Spectrol
*R60	Resistor, Metal film 110K, 1/4W, 1%	RN55D 1103F	
J1	P/C edge connector 22 contact	50-22A-20	TRW/cinch

*Nominal value. Actual value may vary with application.
**C6,7 used on 3Ø models only.



BISHOP GRAPHICS/ACCUPRESS
REORDER NO A11715



NOTE:

1. C13 AND R36 USED AS REQUIRED.
2. D13 AND D14 MAY BE REPLACED WITH JUMPER AS REQUIRED.
3. C11 USED AS REQUIRED. INSTALLED ON CIRCUIT SIDE.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY
DATE 10/31/83	SCHEMATIC: B-1274/A
TITLE COMPONENT LAYOUT	
MODEL DR-9	DRAWING NO. B-1219/A

BISHOP GRAPHICS/ACCUPRESS
RECORDER NO. A11213

PARTS LIST

Description DRIVER

Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
A1,2	Operational Amplifier	CA3140T	RCA
A3	Quad Operational Amplifier	TL084CN	TI
C1	Capacitor, Disk .15uF, 50V	SR205E154MAA	AVX
C2,3	Capacitor, Disk .1uF, 50V	SR205E104MAA	AVX
C4,8,9	Capacitor, Disk 1000pF, 1000V	DD-102	Centralab
C5,7	Capacitor, Electrolytic 25uF, 25V	TVA-1205	Sprague
C6	Capacitor, Monolythic 1.0uF, 50V	5CZ5U105X0050C5	Sprague
C10	Capacitor, Disk .05uF, 100V	TG-S50	Sprague
C11	Capacitor, Disk .02uF, 100V (use as required)	TG-S20	Sprague
C12,14	Capacitor, Mica 68pF, 500V	CM05ED680J03	CDE
*C13	Capacitor, Mica 2500pF, 500V	CMO6FD252JO3	CDE
D1,2,7-12	Diode, Signal 20mA, 100V	1N914A	Fairchild
D3-6	Not used		
D13,14	Diode, Signal 20mA, 100V (used as required)	1N914A	Fairchild
Q1,2	Field Effect Transistor	VN88AF	Siliconix

PARTS LIST

Description DRIVER

Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
Q3	Transistor, NPN	2N5308	RCA
*R1	Resistor, Metal film 15K, 1/4W, 1%	RN55D 15002F	
R2,5,18	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R3	Resistor, Metal film 9.53K, 1/4W, 1%	RN55D 9531F	
R4,26,27	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
*R6,8	Resistor, Metal film 1.10M, 1/4W, 1%	RN55D 1104F	
R7,9	Resistor, Metal film 205K, 1/4W, 1%	RN55D 2053F	
*R10	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R11,14	Potentiometer, Trimming 5K, Single turn	72XR5K	Beckman
R12	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R13	Resistor, Metal film 4.7K, 1/4W, 1%	RN55D 4701F	
R15	Resistor, Metal film 392 Ohm, 1/4W, 1%	RN55D 3920F	
R16,19	Not used		
R17,22,37 *R25	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R20	Resistor, Metal film 681 Ohm, 1/4W, 1%	RN55D 6810F	

PARTS LIST

Description DRIVER

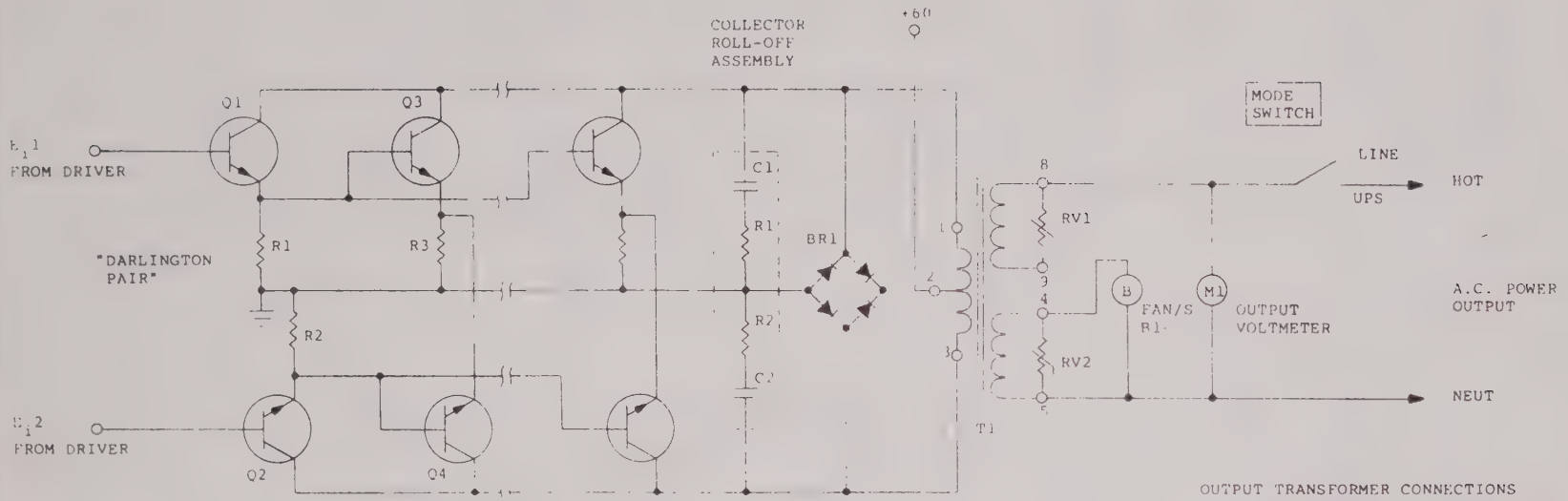
Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
*R21	Resistor, Metal film 78K, 1/4W, 1%	RN55D 7802F	
R23,29,30	Resistor, Metal film 100 Ohm, 1/4W, 1%	RN55D 1000F	
*R24	Resistor, Metal film 12.1K, 1/4W, 1%	RN55D 1212F	
*R33	Resistor, Metal film 1.5K, 1/4W, 1%	RN55D 1501F	
*R28	Resistor, Wirewound 250 Ohm, 10W	RW68 V251	Dale
R31,34	Resistor, Metal film 3.01K, 1/4W, 1%	RN55D 3011F	
*R32,35	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
R36	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
U1	Photodiode	CLM 60	Clairex
Z1,2	Zener diode 14V, 5W	1N5244A	Motorola
Z3	Zener diode 75V, 1W	1N4761A	Motorola
1 pc	Printed circuit board	DR-9	Behlman Eng.
1 pc	P/C edge connector 22 contact	50-22A-20	TRW/Cinch
1 pc	Heat sink	29-001	Behlman Eng.

* Nominal value, actual value may vary with application.



OUTPUT TRANSFORMER CONNECTIONS

OUTPUT VOLTAGE	CONNECTIONS	OUTPUT TAPS
130	5-9 & 4-8	5 & 8
260	4-9	5 & 8

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 9/21/83	REVISED
TITLE POWER OUTPUT STAGE UPS MODELS	
MODEL 100-1000VA	DRAWING NO. B-1999

BISHOP GRAPHICS/ACCUPRESS
REORDER NO 411216

PARTS LIST

Description POWER OUTPUT STAGE

Model UPS-50

Assembly/part no.

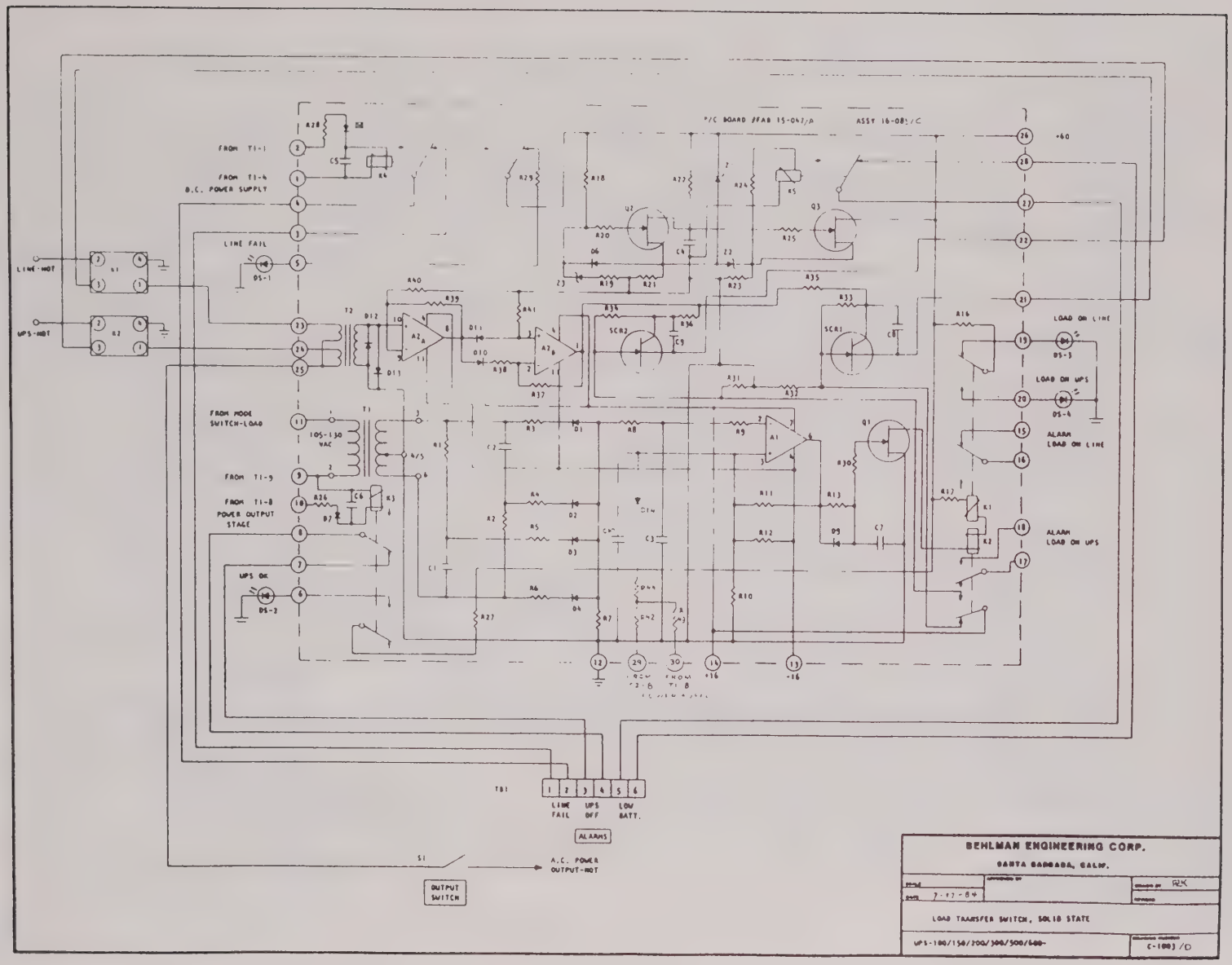
Drawing/ref no. B-1999

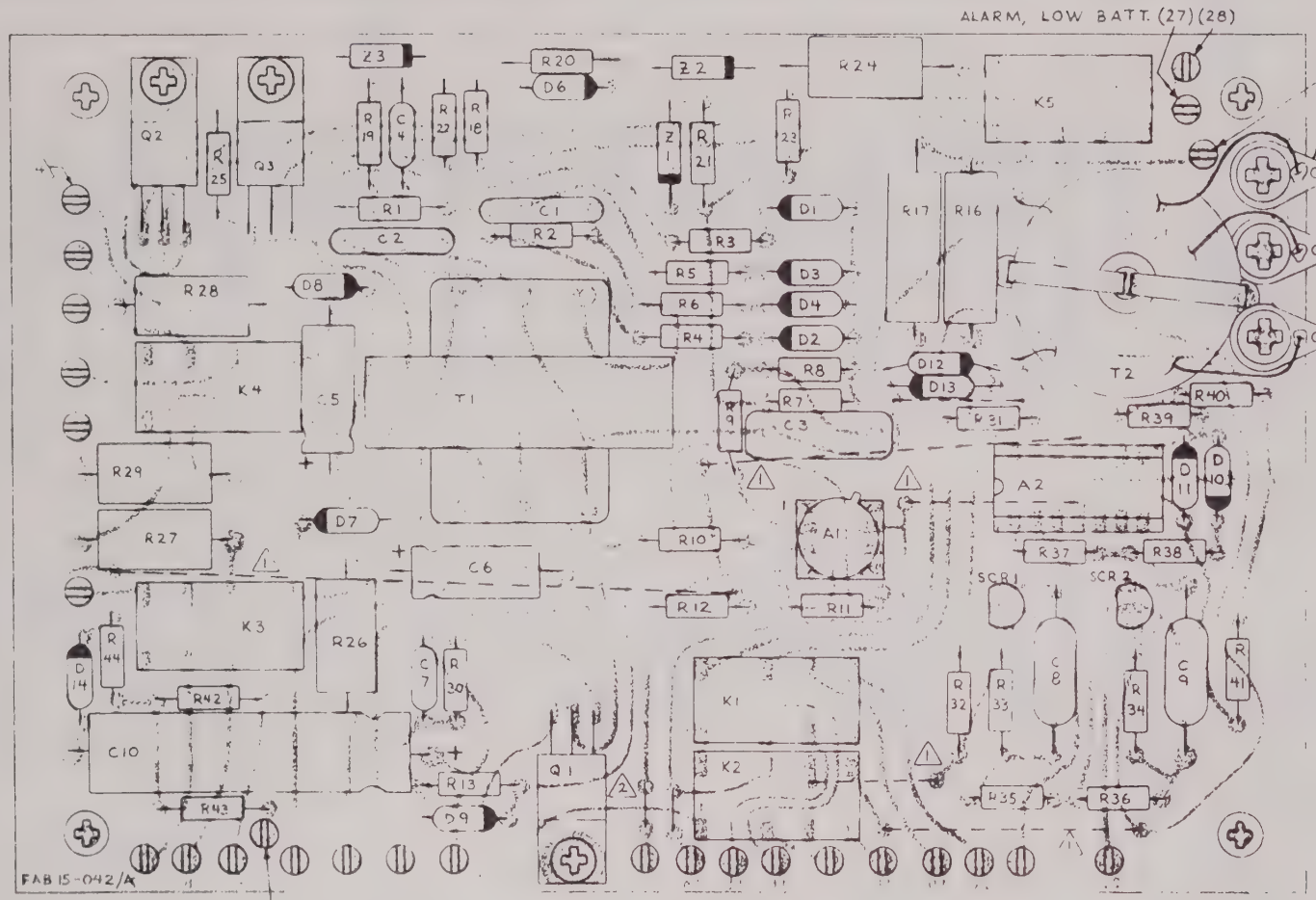
Page 1 of 1

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
B1,2	Fan 115V, 115 CFM	4600X	Pamotor
BR1	Bridge rectifier 25A, 200V	250JB2L	IR
M1	Voltmeter, AC 0-150V, Rectifier type	2BA3-AVV-150	Modutec
Q1-16	Transistor, Power, NPN	2N6259	RCA
R1,2	Resistor, Wirewound 1 ohm, 3W	RW69V2R0	Dale
R3-9	Resistor, Wirewound 0.5 ohm, 3W	RW69VR50	Dale
RV1,2	Varistor	V150LA20B	GE
S1	Switch, Toggle SPST, 15A, 125V	7501K13	Cutler-Hammer
T1	Transformer, Power output	PO-50-C-2B	Behlman Eng.

COLLECTOR ROLL-OFF, ASSEMBLY 16-009:

C1,2	Capacitor, Metallized film 2.0uF, 200V	2DF-M2	Sprague
R1,2	Resistor, Wirewound 1 ohm, 3W	RW69V1R0	Dale
1 pc	Printed circuit board	R/O-5	Behlman Eng.


P/C BOARD #FAB 15-047/A
ASSY 16-081/C
FROM T1-1
FROM T1-4
D.C. POWER SUPPLY
LINE FAIL
DS-1
LINE-HOT
UPS-HOT
FROM MODE SWITCH-LOAD
105-130 VAC
FROM T1-9
FROM T1-8
POWER OUTPUT STAGE
UPS OK
DS-2
+60
LOAD ON LINE
DS-3
LOAD ON UPS
DS-4
ALARM LOAD ON LINE
ALARM LOAD ON UPS
TB1
LINE FAIL
UPS OFF
LOW BATT.
ALARMS
S1
A.C. POWER OUTPUT-HOT
OUTPUT SWITCH
BEHLMAN ENGINEERING CORP.
SANTA BARBARA, CALIF.
7-12-84
LOAD TRANSFER SWITCH, SOLID STATE
UPS-100/150/200/300/500/600-
C-1003 /D


ALARM, LOW BATT. (27)(28)
(26) +60V
(25) TO OUTPUT SWITCH
(24) FROM UPS S.S. RELAY, K2-1
(23) FROM LINE S.S. RELAY K1-1
FROM PT1-4 (1)
FROM PT1-1 (2)
ALARM LINE FAIL (3) (4)
TO LINE FAIL LED, DS-1 (5)
TO UPS OK LED, DS-2 (6)
NOTES
1 JUMPER 26AWG TEFLON CIRCUIT SIDE
2 JUMPERS 26AWG, COMPONENT SIDE
3 NO. 6 SOLDER LUG (3 EA.)
4 BIFURCATED TERMINAL
FAB 15-042/A
(7) (8) ALARM UPS OFF
(29) FROM PT2-8
(30) FROM PT1-8
(9) FROM OT1-9
(10) FROM OT1-8
(11) FROM MODE SWITCH-LOAD
(12) GND
(13) -16V
(14) +16V
(15) (16) ALARM LOAD ON LINE
(17) (18) ALARM LOAD ON UPS
(19) TO LOAD ON LINE LED, DS-3
(20) TO LOAD ON UPS LED, DS-4
(21) TO LINE S.S. RELAY, K1-3
(22) TO UPS S.S. RELAY K2-3

Behlman Engineering Corp	
SANTA BARBARA, CALIFORNIA	
DRAWN BY RK	APPROVED BY
DATE 7-17-84	SCHEMATIC: C-1003/D
TITLE COMPONENT LAYOUT, LOAD TRANSFER SWITCH	
MODEL ASSY 16-085/C	DRAWING NO. B-1627/D

© SHOP GRAPHICS/ACCUPRESS REGISTER NO. A11215

PARTS LIST

Description TRANSFER SWITCH SOLID STATE
Assembly/part no. 16-085/C
Drawing/ref no. C-1003/D, B-1627/D

Model

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
A1	Operational amplifier	CA3140T	RCA
A2	Quad operational amplifier	TL084CN	TI
C1,2	Capacitor, Monolythic 2.2uF, 50V	5CZ5U225X0050C5	Sprague
C3	Capacitor, Metallized Film .15uF, 200V	2DF-P15	Sprague
C4	Capacitor, Disk 1000pF, 1000V	DD-102	Centralab
C5,6	Capacitor, Electrolytic 10uF, 25V	TVA-1204	Sprague
C7	Capacitor, Monolythic 1uF, 50V	5CZ5U105X0050C5	Sprague
C8,9	Capacitor, Disk .05uF, 100V	TG-S50	Sprague
C10	Capacitor, Electrolytic 20uF, 150V	TVA-1410	Sprague
D1-4,7,8, 10-14	Diode 1A, 400V	1N4004	Motorola
D5	Not used		
D6	Diode, Shottkey 1A, 20V	1N5817	Motorola
D9	Diode, Switching 200mA, 100V	1N914A	ITT
K1-5	Relay, DPDT 24 VDC Coil, 1 Amp Contacts	RZ-24	ITT
Q1,2,3	Field Effect Transistor	25K213	Hitachi
R1	Resistor, Metal Film 1.24K, 1/4W, 1%	RN55D 1241F	

PARTS LIST

Description TRANSFER SWITCH
SOLID STATE
Assembly/part no. 16-085/C
Drawing/ref no. C-1003/D, B-1627/D

Model

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R2	Resistor, Metal film 1.13K, 1/4W, 1%	RN55D 1131F	
R3-6	Resistor, Metal Film Select at Test.	RN55D	
R7,8,23, 30,39	Resistor, Metal Film 100K, 1/4W, 1%	RN55D 1003F	
R9,31,32	Resistor, Metal Film 10K, 1/4W, 1%	RN55D 1002F	
*R10	Resistor, Metal Film 13.7K, 1/4W, 1%	RN55D 1372F	
R11	Resistor, Metal Film 604K, 1/4W, 1%	RN55D 6043F	
R12	Resistor, Metal Film 15K, 1/4W, 1%	RN55D 1502F	
R13	Resistor, Metal Film 1 MEG, 1/4W, 1%	RN55D 1004F	
R14,15	Not Used		
R19,40	Resistor, Metal Film 1K, 1/4W, 1%	RN55D 1001F	
R16,27,29	Resistor, Carbon Comp. 5.1K, 1W, 5%	RC32 GF512J	Allen-Bradley
R17	Resistor, Carbon Comp. 1K, 1W, 5%	R32 GF102J	Allen-Bradley
R18	Resistor, Metal Film Select at Test (APPROX. 60K)	RN55D	
R20,21,43	Resistor, Metal Film 5.11K, 1/4W, 1%	RN55D 5111F	

PARTS LIST

Description TRANSFER SWITCH
SOLID STATE

Model

Assembly/part no. 16-085/C

Page 3 of 4

Drawing/ref no. C-1003/D, B-1627/D

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R22	Resistor, Metal Film 499K, 1/4W, 1%	RN55D 4993F	
*R24	Resistor, Carbon Comp. 2.0K, 2W, 5%	RC42 GF202F	
R25	Resistor, Metal Film 4.75K, 1/4W, 1%	RN55D 4751F	
R26,28	Resistor, Wirewound 2K, 3W	5AE2000	Mallory
R33,34	Resistor, Metal Film 110K, 1/4W, 1%	RN55D 1103F	
R35,36	Resistor, Metal Film 49.9K, 1/4w, 1%	RN55D 4992F	
R37,38,42	Resistor, Metal film 5.62K, 1/4W, 1%	RN55D 5621F	
R41	Resistor, Metal Film 9.09K, 1/4W, 1%	RN55D 9091F	
*R44	Resistor, Metal film 2.21K, 1/4W, 1%	RN55D 2211F	
SCR1,2	Silicon Controlled Rectifier	2N5064	Motorola
T1	Transformer	F139P	Triad
T2	Transformer, Torroid 2 Primaries: Select At Test 1 Secondary: 56T #26		Behlman Eng.
Z1	Zener Diode 51V, 1W	1N4757	IR
Z2	Zener Diode 47V, 1W	1N4756	IR

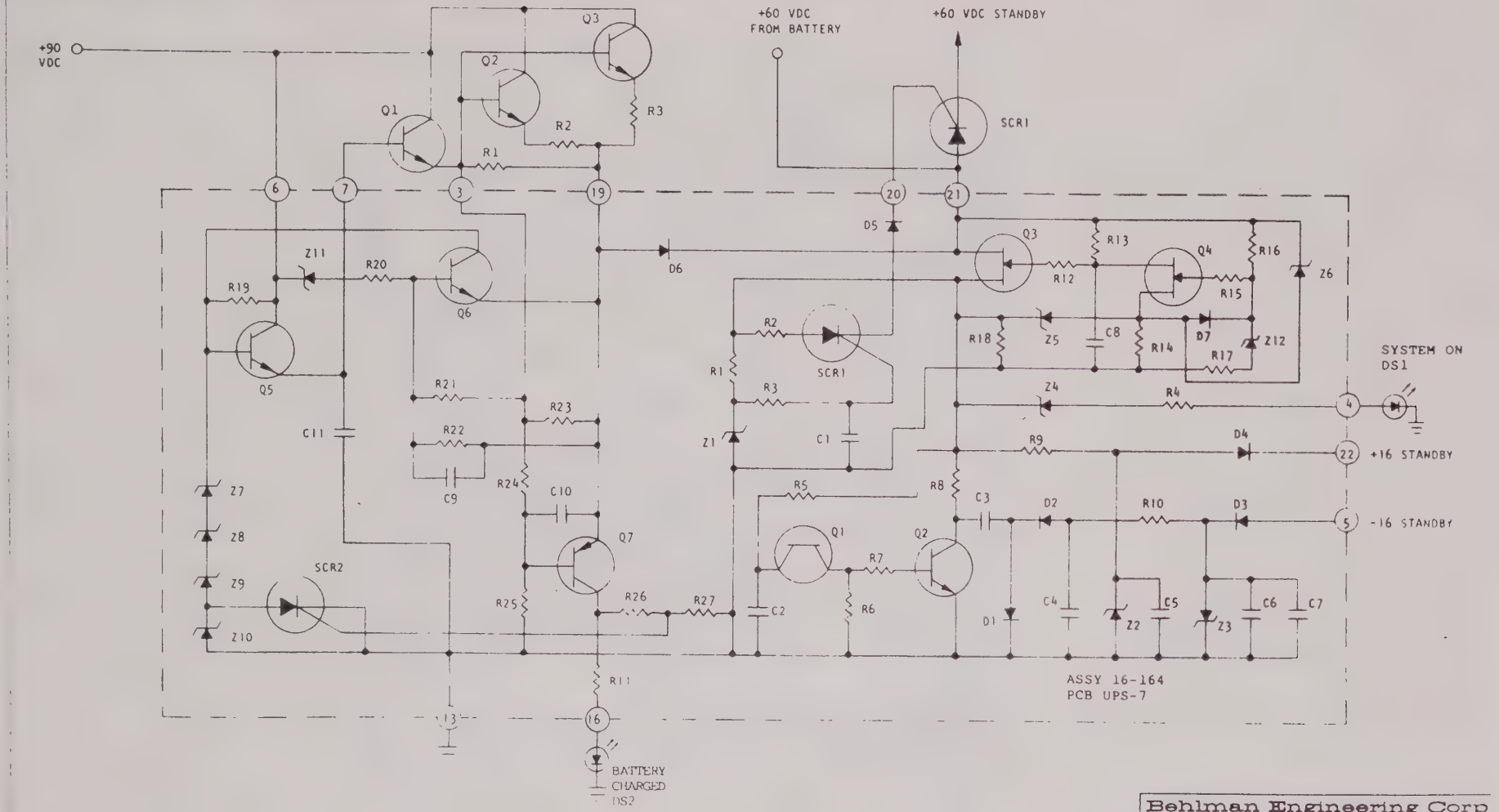
PARTS LIST

Description TRANSFER SWITCH
SOLID STATE
Assembly/part no. 16-085/C
Drawing/ref no. C-1003/D, B-1627/D

Model

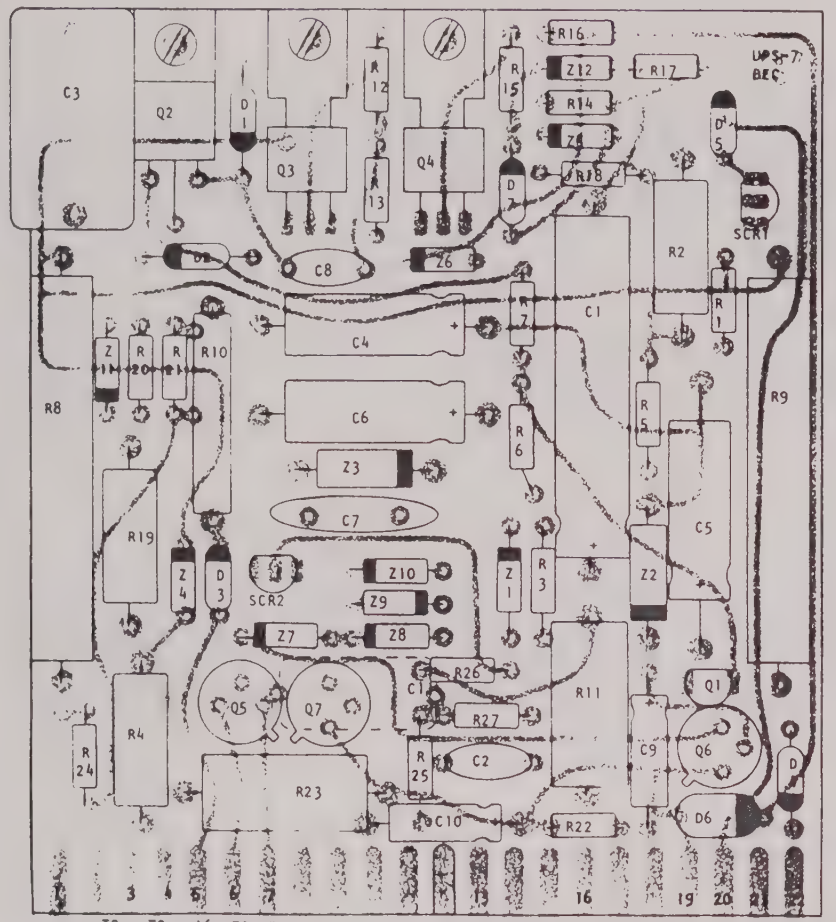
REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
Z3	Zener Diode 5.1V, 1W	1N4733	IR
1 pc	Printed Circuit Board	15-042/A	Behlman Eng.
CHASSIS COMPONENTS/ASSEMBLIES			
DS1	Led Cartridge, Red	507-4756-3331-500	Dialco
DS2-4	Led Cartridge, Green	507-4856-3332-500	Dialco
K1,2	Relay, Solid State 100-2000 VA: Control: 3-32 VDC Load: 240 VAC, 40A	D2440	IR/Crydom
	3000-6000 VA: Control: 3-32 VDC Load: 240 VAC, 75A	D2475	IR/Crydom
S1	Toggle Switch DPDT, 15A, 125V	7561K4	Cutler-Hammer
TB1	Terminal Block 15A, 6 Terminal	6-140-Y	TRW/Cinch

*Nominal value. Actual value may vary with application.



Behlman Engineering Corp		
SANTA BARBARA, CALIFORNIA		
DRAWN BY PLK	APPROVED BY	
DATE 9/27/83	REVISED	
TITLE UPS ADAPTOR & BATTERY CHARGER 1-3 AMPERES		
MODEL	DRAWING NO B-1357/A	

B-SHOP GRAPHICS: ACCUPRESS
REORDER NO A11715



(COMPONENT SIDE)

NOTES:

1. C11 ON CIRCUIT SIDE.
2. D6 USED WITH UP TO 3 AMPERE CHARGERS ONLY.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY
DATE 9/27/83	REVISED
TITLE COMPONENT LAYOUT, UPS ADAPTOR & BATTERY CHARGER, 1-3 AMPERES	
MODEL ASSY 16-164	DRAWING NO B-1419/A

BISHOP GRAPHICS/ACCUPRESS
REORDER NO A11218

PARTS LIST

Description UPS ADAPTOR/ BATTERY CHARGER (1-3 AMPERE)
Assembly/part no. 16-164
Drawing/ref no. B-1357/A, B-1419/A

Model 100-1000 VA

Page 1 of 4

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1	Capacitor, Electrolytic 20uF, 150V	TVA-1410	Sprague
C2,8	Capacitor, Disk 1000pF, 1000V	DD102	Centralab
C3	Capacitor, Metallized film 2uF, 200V	2DF-M2	Sprague
C4-6	Capacitor, Electrolytic 100uF, 25V	TVA-1207	Sprague
C7	Capacitor, Disk .1uF, 25V	UK25104	Centralab
C9,10	Capacitor, Electrolytic 8uF, 25V	TVA-1203	Sprague
C11	Capacitor, Metallized film .33uF, 200V	2DF-P33	Sprague
D1-5	Diode 1A, 400V	1N4004	Motorola
D6	Diode 6A, 100V	60S1	IR
D7	Diode, Schottky 1A, 20V	1N5817	Motorola
Q1	Diac 100mA, 36V	1N5762A	Motorola
Q2	Transistor, Darlington, NPN 10A, 80V	D44E3	GE
Q3,4	Field effect transistor 1A, 80V	VN88AF	Siliconix
Q5,6	Transistor, NPN 1A, 250V	2N3440	RCA
Q7	Transistor, PNP 1A, 300V	2N5416	RCA
R1,26	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	

PARTS LIST

Description UPS ADAPTOR/ BATTERY CHARGER (1-3 AMPERE)
Assembly/part no. 16-164
Drawing/ref no. B-1357/A, B-1419/A

Model 100-1000 VA

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R2	Resistor, Carbon comp. 220 ohm, 1W, 5%	RC32 GF221J	Allen-Bradley
R3,17	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R4	Resistor, Carbon comp. 1.8K, 1W, 5%	RC32GF182J	Allen-Bradley
R5,13	Resistor, Metal film 499K, 1/4W, 1%	RN55D 4993F	
R6,7	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
*R8	Resistor, Wirewound 350 ohm, 10W	RW68 V351	Dale
*R9	Resistor, Wirewound 500 ohm, 10W	RW68 V501	Dale
R10	Resistor, Wirewound 30 ohm, 5W	5AE30	Mallory
R11	Resistor, Carbon comp. 4.7K, 2W, 5%	RC42 GF472J	Allen-Bradley
R12	Resistor, Metal film 4.75K, 1/4W, 1%	RN55D 4751F	
R14,15	Resistor, Metal film 5.1K, 1/4W, 1%	RN55D 5101F	
R16	Resistor, Metal film Select at test Approx. 1M, 1/W, 1%	RN55D 1004F	
R18	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R19	Resistor, Carbon comp. 10K, 1W, 5%	RC32 GF103J	Allen-Bradley
*R20	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	

PARTS LIST

Description UPS ADAPTOR/ BATTERY CHARGER (1-3 AMPERE)
Assembly/part no. 16-164
Drawing/ref no. B-1357/A, B-1419/A

Model 100-1000 VA

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R21	Resistor, Metal film Select at test Approx. 2K, 1/4W, 1%	RN55D 2001F	
*R22	Resistor, Metal film 1.5K, 1/4/W, 1%	RN55D 1501F	
R23	Resistor, Carbon comp. 10 ohm, 2W, 5%	RC42 GF100J	Allen-Bradley
R24	Resistor, Metal film Select at test Approx. 825 ohms, 1/4W, 1%	RN55D 8250F	
R25	Resistor, Metal film 16K, 1/4W, 1%	RN55D 1602F	
R27	Resistor, Metal film 475 ohm, 1/4W, 1%	RN55D 4750F	
SCR1,2	Silicon controlled rectifier 800mA, 200V	2N5064	Motorola
Z1	Zener diode 56V, 1W, 1%	1N4758D	Motorola
Z2,3	Zener diode 16V, 5W	1N5353B	Motorola
Z4,7,8	Zener diode 30V, 1W	1N4751	Motorola
*Z5	Zener diode 30V, 1W in series with 14V, 1/2W	1N4751 1N5244	Motorola Motorola
*Z6	Zener diode Two 30V, 1W in series	1N4751	Motorola
*Z9	Zener diode 12V, 1W	1N4742	Motorola
Z10,12	Zener diode 5.1V, 1W	1N4733	Motorola

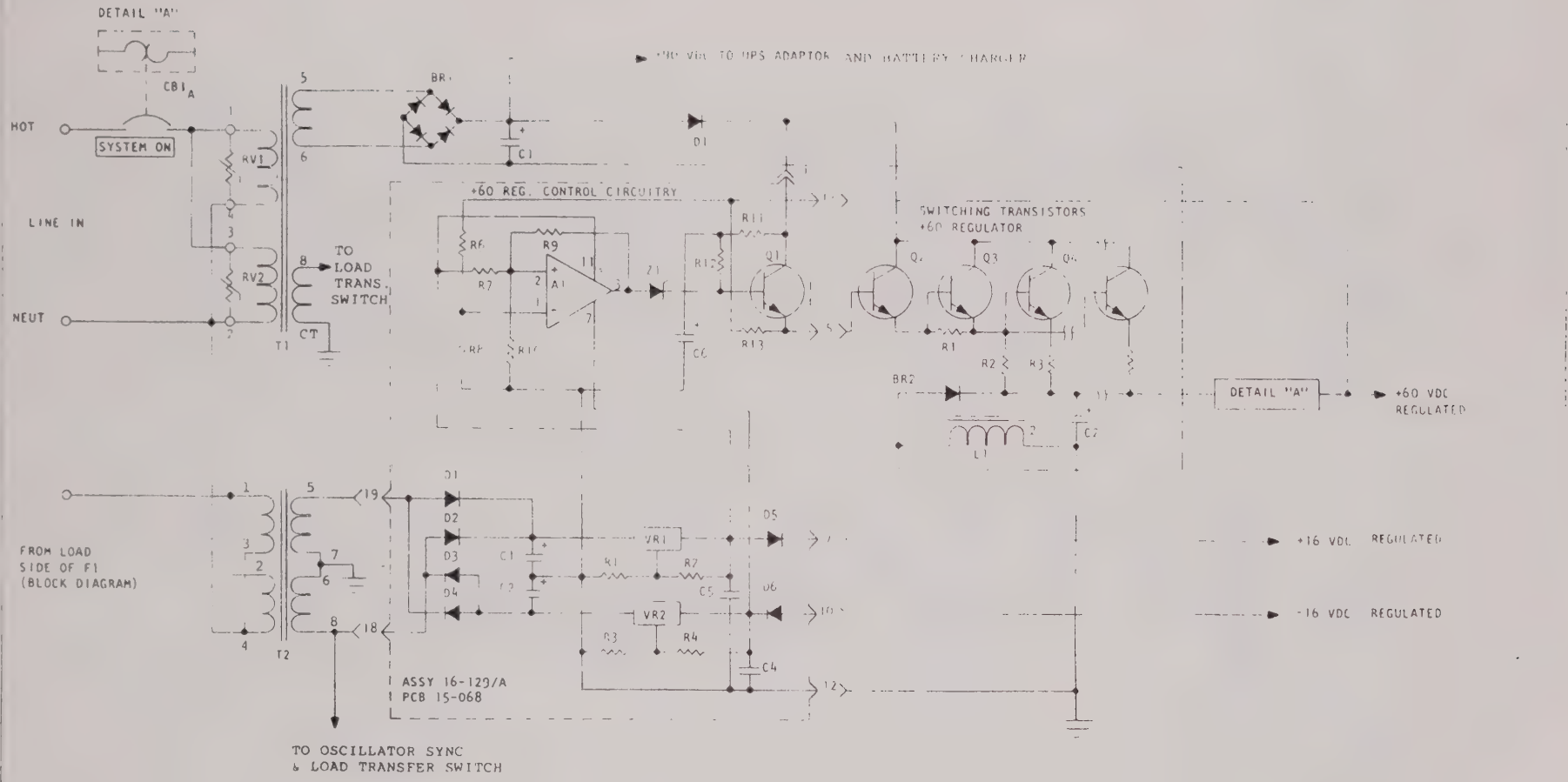
PARTS LIST

Description UPS ADAPTOR/ BATTERY CHARGER (1-3 AMPERE)
Assembly/part no. 16-164
Drawing/ref no. B-1357/A, B-1419/A

Model 100-1000 VA

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
*Z11	Zener diode 30V, 1W	1N4751	Motorola
1 pc	Printed circuit board	UPS-7	Behlman Eng.
CHASSIS COMPONENTS/ASSEMBLIES:			
DS1	LED, Cartridge 3.6V, Green	507-4856-3332-500	Dialco
DS2	LED, Cartridge 3.6V, Amber	507-4956-3333-500	Dialco
**Q1-3	Transistor, Power, NPN 16A, 150V	2N6259	RCA
R1	Resistor, Wirewound 1 ohm, 3W	RW69V1R0	Dale
**R2,3	Resistor, Wirewound 0.5 ohm, 3W	RW69VR50	Dale
SCR1	Silicon controlled rectifier 100-750 VA models: 35A, 100V	2N3896	Motorola
	1000 VA models: 63A, 100V	C147A	GE

*Nominal value. Actual value may vary with application.
**Q2,3 & R2,3 used only on models with 3 ampere charger.



Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY
DATE 7/17/84	REVISED
TITLE D.C. POWER SUPPLY UPS MODELS, 115 VOLT, INPUT	
MODEL 350-1000 VA	DRAWING NO B-2307

PARTS LIST

Description D.C. POWER SUPPLY

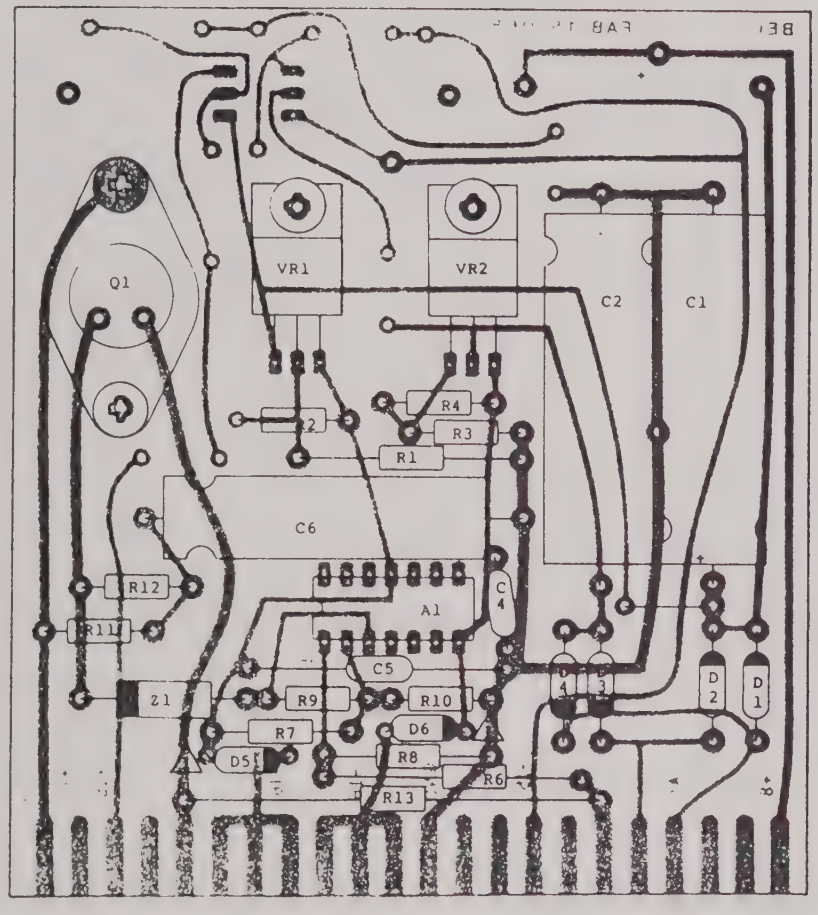
Model UPS-50

Assembly/part no.

Drawing/ref no. B-2307

Page 1 of 1

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
BR1	Bridge rectifier 50A, 200V	MPI-5020	EDI
BR2,	Bridge rectifier 25A, 200V	250JB2L	IR
C1,2	Capacitor, Electrolytic 5200uF, 150V	CGS522U150W4C	Mallory
CB1	Circuit breaker, 3 pole	UPG-666-4-60-502	Airpax
D1	Diode, Bridge rectifier 25A, 200V	250JB2L	IR
J1	P/C edge connector 22 contact	50-22A-20	TRW/Cinch
L1	Reactor 0.6mH, 16A	L-0006-16	Behlman Eng.
Q2-6	Transistor, Power, NPN	2N6259	RCA
R1,2	Resistor, Carbon comp 10 ohm, 2W, 5%	RC42 GF 100J	Allen-Bradley
R3-5	Resistor, Wirewound 0.1 ohm, 10W	RE65GR100	Dale
RV1,2	Varistor	V150LA20B	GE
T1	Transformer, Power Input	PT-8-20-2-K	Behlman Eng.
T2	Transformer, Power Input	PC3715	Microtran
TB1	Termanil block 30A, 3 terminal	3-142-Y	TRW/Cinch
1pc	P/C Assembly Power supply, Regulated	16-129/A	Behlman Eng.



NOTE:

1. REMOVE TRACES UNDER D5 & D6

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY HA	APPROVED BY
DATE 9/14/83	REVISED
TITLE COMPONENT LAYOUT UPS D.C. POWER SUPPLY	
MODEL ASSY 16-129/A	DRAWING NO. B-1462/B

SHOP GRAPHICS ACTUAL SIZE
ORDER NO. A11215

PARTS LIST

Description D.C. POWER SUPPLY REGULATED
Assembly/part no. 16-129/A
Drawing/ref no. B-1462/B

Model UPS-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
A1	Quad operational amplifier	RC4136DB	Raytheon
C1,2	Capacitor, Electrolytic 500uF, 25V	TVA-1209	Sprague
C3	Not used		
*C4,5	Capacitor, Monolythic 2.2uF, 50V	5CZU225X0050C5	Sprague
C6	Capacitor, Electrolytic 20uF, 150V	TVA-1410	Sprague
D1-6	Diode 1A, 400V	1N4004	Motorola
Q1	Transistor, NPN	2N3583	RCA
*R1,3	Resistor, Metal film 47 ohm, 1/4W, 1%	RN55D 4700F	
R2,4	Resistor, Metal film 1.5K, 1/4W, 1%	RN55D 1501F	
R5	Not used		
*R6	Resistor, Metal film 51.1K, 1/4W, 1%	RN55D 5112F	
R7	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R8	Resistor, Metal film 13.7K, 1/4W, 1%	RN55D 1372F	
R9	Resistor, Metal film 887K, 1/4W, 1%	RN55D 8873F	
R10	Resistor, Metal film 110K, 1/4W, 1%	RN55D 1103F	
R11	Resistor, Metal film 2.2K, 1/4W, 1%	RN55D 2201F	

PARTS LIST

Description D.C. POWER SUPPLY REGULATED

Assembly/part no. 16-129/A

Drawing/ref no. B-1462/B

Model UPS-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R12	Resistor, Metal film 22K, 1/4W, 1%	RN55D 2202F	
R13	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
VR1	Voltage regulator +15V (adjustable), 1.5A	MC7815CT	Motorola
VR2	Voltage regulator -15V (adjustable), 1.5A	MC7915CT	Motorola
Z1	Zener Diode 62V, 5W	1N5372B	IR
1 pc	IC socket, 14 contact	14S-TSD	CA
1 pc	Printed circuit board	15-068	Behlman Eng.

*Nominal value, actual value may vary with application

BEHLMAN QUALITY PRODUCTS

Standard AC Power Sources
Single, two, and three-phase precision AC power sources are available with a selection of power outputs from 100 VA to 54 KVA and fixed or variable frequencies from 45 Hz to 10 kHz.

Programmable AC Power Sources
Laboratory quality AC power sources designed for precise local or remote control of output voltages, frequency, and phase relationships. All major remote programming inputs are accommodated including IEEE-488, binary, and DC voltage. Models range from 100 VA to 54 KVA in single, two, and three-phase configurations. Frequency ranges from 45 Hz to 10 kHz are standard.

Uninterruptible Power Systems
The ultimate solution to power disturbance problems. Reliability and excellence are engineered into every BEHLMAN UPS product. Models are available with power outputs from 100 VA to 7.5 KVA for single-phase models and from 3 KVA to 20 KVA for three-phase models. As with all Behlman products, these UPS generate virtually no EMI/RFI.

REPRESENTED BY:

BEHLMAN
Engineering Corporation
Electronic Energy Conversion Sources & Systems

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